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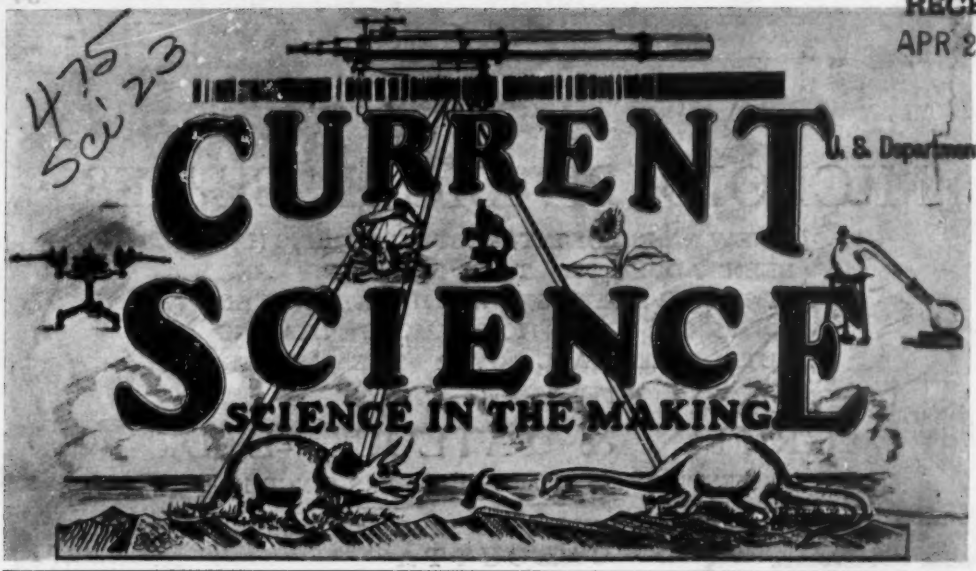

Vol. II] MARCH 1934 [No. 9

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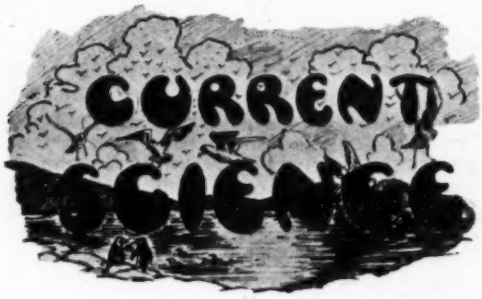

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Census of India, 1931.

THERE is an imposing array of statistical tables and graphs in the Census Report of 1931, illuminated by a clever exposition of some of the fundamental problems of human population relevant to them. According to the figures provided in the Report, India occupies the foremost place among the countries of the world in the number of inhabitants and if the rate of increase such as occurred between 1871 and 1881, *viz.*, 47·74 millions were to be steadily maintained, she would almost certainly continue to hold this dizzy eminence indefinitely. But instead of being a matter of satisfaction, it might well prove a source of irritating embarrassment to the statesmen guiding her destinies. The actual increase in the number of population of this country which has occurred in the last decade is estimated at a figure which approaches equality with that of European countries like France and Italy and exceeds that of Spain and Poland. The urban areas have contributed about 19·2 per cent. to this total increase of nearly 34 millions while the remainder represents the increment supplied by the inhabitants of the rural parts of India. A population of such magnitude as 354 millions spread over an area of eighteen hundred thousand square miles must fill the mind of both the government and discerning public with grave apprehensions and even some of the subsidiary problems such as the relative proportions in the number of men and women at their reproductive ages, the number of births and infantile mortality, the agricultural holdings and the occupations of the people, unemployment, migration of the people and a number of other allied questions have an importance and significance peculiar to India. The satisfactory solution of any of these or all of them must baffle the resources of the most accomplished statesmen even if each of the problems should remain without further complications. Judging by the comparative tables provided in the report, the inference may naturally be drawn that further increase of Indian population will render the problems still more complex and their solution must present insuperable difficulty. The grave aspects of these questions, it appears to us, should engage the attention of the people themselves no less than that of the Government and the attack should be made

in a spirit of mutual understanding and helpful co-operation.

Almost all the recent writers on the population problem discuss it in relation to the question of food supply. It is argued that in India, the great masses of rural population who live perpetually on the verge of insufficiency would become involved in a serious economic position if further accretions are permitted to occur without let or hindrance. This, however, is a contingency which according to the Census Report has not arrived, but no one can afford to ignore the need for so regulating the growth of population that it is able to subsist on the produce of the land without further imperilling the standard of living. It ought to be the endeavour of the people to raise the standard, if possible, so that their children are provided with the means of obtaining the benefits of education and employment in the professions for which they are best fitted. The remedy usually suggested for checking the indiscriminate and excessive increase of population is the widespread practice of contraceptive methods. Some of the advanced thinkers are so convinced of the efficacy of this doctrine that they lend the weight and authority of their names to the movement which advocates the introduction of birth control methods.

"The present problem in India," writes Dr. J. H. Hutton, "would seem to be less the actual total increase of the population than the increase of that portion of the population, by far the greater part of course, which is occupied in agricultural and allied pursuits." This statement based on a careful analysis of the Census figures, acquires a great significance when it is remembered that in India even at the present moment the profession of agriculture continues in most parts to be looked upon by the rural community as an end in itself rather than "as a mere means of production of victuals, hence the real danger of a growth of population which must suffer discomfort because this end becomes rapidly more difficult of realisation." If the argument in favour of the limitation of population by artificial methods is based exclusively on the means of subsistence, then its advocates do not appear to have a strong case. Writing on the theories of the problem of population growth in Bengal where the mean density is 611 persons per square mile, Mr. A. E. Porter observes that "during the last 60 years the population of this province has become nearly half as large again as it was in 1872.... Of the total area cultivable only 67 per cent. is now actually under cultivation. If the total cultivable area were brought under cultivation and if improved methods of cultivation yielding an increase of 30 per cent. over the present yield were adopted, then it is clear from a simple rule of three calculation that Bengal could support at its present standard of living a population very nearly twice as large as that recorded in 1931." The conditions of rural life in Bengal are not different from those in other Presidencies and if the apprehension that the people in Bengal would be reduced to the verge of starvation by further accretions to her population is not tenable then we believe that the pessimism entertained in regard to the future population of India as a whole, is premature. The possibilities of improving the natural resources of India are practically unlimited and the capacity of the land now under cultivation and what is likely to be brought under agriculture during the next six decades, may be found adequate to support a further addition of 90 millions to the existing population. This period may perhaps suffice to carry the mechanical and biological developments in the methods of cultivation to a point of perfection which would meet the requirements of India sixty years hence. In India further increase of population is inevitable, if not checked by the operation of natural forces, and steps have to be taken therefore for framing a comprehensive programme of scientific investigations for stimulating the fertility of the land and the yield of crops. Perhaps the same period might also witness the organisation of industries on a larger scale which eventually might relieve the possible congestion of the rural population. Without such relief land-holdings would become too small to be economical.

It seems to us that at the present moment, the remedy suggested to limit the population of India within reasonable bounds, purely for economic reasons, does not receive support from the Census figures and the interpretation of them. However, birth-control methods might be found necessary to form part of the social programme of this country if Western conditions and ideals of life, the economic fever and fret of competition were reproduced here on the scale of the most advanced European countries where this doctrine of

regulating the birth of babies is generally accepted. In India the conditions are still not quite favourable for universally welcoming this wild goose that lays no eggs.

The North Bihar Earthquake of the 15th January, 1934.*

By M. S. Krishnan, M.A., Ph.D., A.R.C.S., D.I.C.,
Geological Survey of India.

ON Monday the 15th January 1934, at about 14 h. 14 m. (I. S. T.), Calcutta experienced an earthquake shock of fair intensity which lasted for over three minutes. Buildings swayed, freely hanging objects oscillated vigorously, and even persons in motion were affected. From past experience of earthquakes in Calcutta, it was clear that this one must have effected considerable damage to life and property at the place of origin. News from the country was available only next morning, showing that Patna, Monghyr and Jamalpur had suffered severely. News from the most affected region arrived only two or three days later. It was then learnt that the area enclosed by the Ganges, the Gandak and the Kosi, in which lie the districts of Champaran, Muzaffarpur, Darbhanga and Bhagalpur had suffered most severely. Authentic news was difficult to obtain from here as well as from the adjoining parts of Nepal, as the communications—roads, railways and telegraphs—were cut off and took some days to restore even partially.

The shock was felt throughout the greater part of the Indian Empire, in the Punjab on the west, in several places in the Madras Presidency on the south, and on the Arakan coast to the east. Seismograph stations reported that the main shock lasted for over 20 minutes and that some 13 milder shocks were registered during the night of the same day. Several after-shocks of varying intensities have continued to be registered since then. As is usual with all violent earthquakes, such after-shocks will probably occur for a few months to come.

NATURE AND EXTENT OF THE DAMAGE.

It is yet too early to estimate the loss of life and property caused by this sudden catastrophe. The official reports have already put the estimated loss of life at over 7,000. The number of injured is also large. The loss of property can be measured only in crores of rupees. The prompt and vigorous relief measures taken by the Government in co-operation with un-official agencies have largely prevented the danger of epidemics, which would otherwise have resulted from the scarcity of drinking water and lack of sanitation.

In the most affected area, the earthquake was attended by the appearance of large rifts or cracks at the surface. Some of these are one to two furlongs long and a foot or more wide. Through these were forced up soft, water-bearing sands and silts and spouts of water. Many wells have been filled with sand or have dried up.

In alluvial areas, the appearance of cracks attended by spouts of water and sand is a common phenomenon during earthquakes. As the surface waves travel along, the layers composing the alluvium are thrown into troughs and crests, soft silt and quick-sand being forced up along openings which might appear in the crests. When the water ceases to flow, crater-like openings are sometimes left in the piles of sand. As some of the layers are rich in organic matter—peat-beds and buried animal remains—they may be expected to yield hydrogen sulphide and hydro-carbon gases when suddenly exposed to the atmosphere. Waters forced up from depths of several tens of feet will also be warm when they first reach the surface. Reports of warm sulphurous waters (which, however, have not been subsequently substantiated) have led the people to a mistaken belief in subterranean volcanic action in this area.

In the Tirhut division the track of the Bengal and North-Western Railway has in many places been buckled, twisted or torn apart. Telegraph and telephone wires have been snapped. Several bridges and culverts have collapsed, and transhipment of passenger traffic has been necessary over several important bridges. In several towns, *e.g.*, Monghyr, Jamalpur, Purnea, Muzaffarpur, Darbhanga, Motihari, Sitamarhi, Samastipur, etc., most of the houses are in ruins. Some of these seem to have been almost

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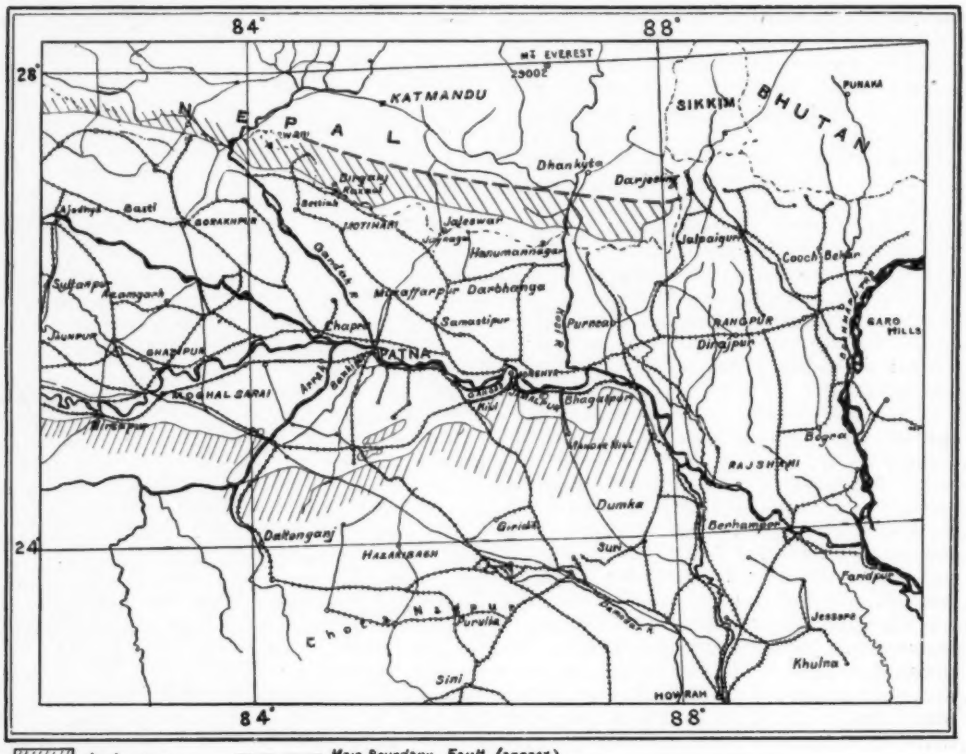


entirely destroyed. About half the number of sugar factories of this area are reported to have been damaged beyond easy repair so that the sugarcane crop is in danger of considerable loss for lack of facilities for crushing. The country-side has been heavily inundated or silted up.

THE EPICENTRAL AREA.

A scrutiny of the reports appearing in the newspapers makes it clear that the most severely affected region lies in the Sitamarhi and Madhubani sub-divisions, lying on the Nepal border between longitudes 85° 0′ and 86° 30′. Katmandu and the neighbouring towns in Nepal are also known to have suffered heavily. The region between Motihari and Monghyr has also been severely affected. It seems therefore that the epicentral area may be roughly located either along the Nepal border or in a tract extending in a N.-W.—S.-E. direction through the districts of Muzaffarpur, Darbhanga and Monghyr. We must await the report of the Geological Survey officers, who are still in the field, before we know of this with any precision.

It will be noticed that the town of Monghyr has been destroyed almost entirely, while its neighbour Jamalpur has suffered severely. This is apparently puzzling and might lead one to infer a focus under Monghyr but different explanations of the phenomena may be possible. Darjeeling is also reported to have been badly shaken but it is now possible to say that the shocks there were not due to the presence of a minor epicentre.

THE ORIGIN OF THE EARTHQUAKE.

It is now known that some 10,000 earthquakes occur per annum over the whole globe, and are recorded by some seismograph station or other. Of these, barely one per cent. may be felt by the people in the immediately adjoining region. Only a few are violent enough to cause destruction of life

and property. The present earthquake undoubtedly belongs to this last group.

By far the great majority of earthquakes are due to the relative displacement of the earth's crust. There are two major tracts on the surface of the globe which are frequently subject to seismic activity: (1) the Circum-Pacific belt or the coastal region surrounding the Pacific Ocean, and (2) the Alpine-Himalayan system of mountain chains. Both these are regions of conspicuous instability. The mountains of the Circum-Pacific belt as well as the Alpine-Himalayan system are comparatively young and are flanked by deep troughs.

Dealing specifically with India, it is well known that the Himalayas together with the Baluchistan arc on the west and the Burma-Malaya arc on the east constitute a region of frequent earthquakes. There are some well marked zones of overthrust or reversed faulting in the Himalayas. The southernmost and youngest of these overthrust zones lies at the base of the Upper Tertiary sandstones and conglomerates known as the Siwalik formations. This overthrust zone is known in Indian Geology as the Main Boundary Fault, as it is a very conspicuous feature along the whole length of the Himalayas from the Punjab to Assam. The Himalayas are constantly being disintegrated and eroded, the resulting material being loaded into the trough of the Indo-Gangetic alluvial region to the south by means of a large number of rivers. According to the principle of isostasy, the crust of the earth floats, so to say, on a sub-stratum at some depth, and the transfer of material from one block to its neighbour causes a relative movement between them. The block which loses the material, *e.g.*, the Himalayas, tends to rise, and the block which receives the material, *e.g.*, the Gangetic alluvium, becomes heavier and tends to sink. A constant state of strain is thus established, which must now and then be released by the relative movement of the affected blocks along a fault zone. These movements set up vibrations which travel outwards as waves and cause earthquakes. It is known that the Main Boundary Fault is the chief zone along which displacements take place in the Himalayan region.

The position of the Main Boundary Fault is roughly known along the road from Raxaul to Katmandu, being about 20 miles to the north of the former town. It proceeds thence eastwards beyond Darjeeling, its outcrop being seen a little to the south of that town. In the intervening area its position can be roughly determined by interpolation, as the whole of Nepal is yet to be mapped geologically. It seems therefore not unlikely that, of the two possibilities mentioned earlier in this note, the epicentral region may overlie the section of the Main Boundary Fault lying to the north of Sitamarhi and Madhubani.

The destruction of Monghyr may probably be attributed to the geological structure of the locality. Monghyr lies on alluvium resting on a spur of Archæan rocks projecting northward under it. This spur has evidently forced the Ganges to make a conspicuous bend convex towards the north, in which the town lies. So the town is situated on a comparatively thin fringe of alluvium reposing against a slope of ancient rocks. It would seem that the waves proceeding from North Bihar were liable to reflection and interference at the junction of two formations of such different characters as alluvium and ancient metamorphic rocks, the inhomogeneity and softness of the alluvium being responsible for the excessive vibration of the foundations of the town.

PREVIOUS EARTHQUAKES IN NORTH BIHAR AND NEPAL.

Newspapers seem to have created an erroneous impression that this region has not been visited by earthquakes before. A reference to the catalogue of Indian earthquakes compiled by Dr. T. Oldham (*Mem. Geol. Surv. Ind.*, **19**, Pt. 3. 1883) shows that the following earthquakes affected the area during the last century:—

3rd August, 1819. Tirhut. Felt in different places. Not severe.

29th October, 1826. Nepal, etc. A great shock followed by eight minor ones. Several houses fell in Katmandu and Patna.

26th August, 1833. Nepal and North-east India. Very violent. Heavy damage in Katmandu, Tirhut, Chapra, Buxar, etc. Several shocks followed for over two months.

10th August, 1843. Darjeeling, Tirhut, Patna.

23rd May, 1843. Terrible shock at Katmandu which destroyed a large part of the town. Felt at Calcutta, Darjeeling, Monghyr, Jubbulpore, etc.

7th July, 1869. Tremendous shock at Katmandu attended by much destruction of life and property.

A party of officers of the Geological Survey of India is studying, in the field, the scientific aspects of the earthquake. Their investigations are expected to occupy several weeks, and the correlated results to be published by the department at an early date.

North Bihar Earthquake of January 15, 1934.

By Dr. S. K. Banerji, D.Sc.

1. INTRODUCTION.

THE earthquake which occurred at about 2–15 P.M. (I.S.T.) on the 15th January 1934 in North Bihar and Nepal is one of the most disastrous and most widely-felt of which we possess any record, and is comparable in severity with the Great Assam Earthquake of 1897 and the Kangra Earthquake of 1905. It has demolished buildings and bridges, damaged railway lines and roads, caused numerous fissures in the ground through which spouted forth water or sand and thus flooded or covered with sand extensive areas. The appearance of a tract extending over about 100,000 square miles was completely changed within the brief interval of 3 or 4 minutes. Thousands were killed or injured and those who survived were thrown into a state of panic. The movements of the ground were felt over almost the whole of northern and central India and as far south as Poona and Bombay.

From the many casual observations, which have been made, it is reported that the 'fault' in the crust very likely stretches the entire way from Motihari to Monghyr, a distance of about 135 miles. There is probably also a second 'fault' beginning somewhere in the middle of the first one and running at an angle to it in the direction of Purnea. Until, however, the map of isoseismal lines is available, it is not possible to define precisely the epicentral tract. For the present, we may consider the epicentral tract to be bounded roughly by an ellipse as shown in Fig. 1. The following epicentral

Fig. 1.

distances have been reported from seismic records:—Bombay 950 miles, Kodaikanal 1,400 miles, Agra 450 miles, Dehra Dun 100 miles, Mangalore 1,250 miles, Kew 4,600 miles. These distances do not fix up any definite centre, nor is it expected that they would do so in a case in which the epicentral tract covers such a wide region, since each station would first receive the waves of different types emanating from the nearest portion of the tract.

The black dots in Fig. 2 show the localities in the Indian area where important earthquakes have occurred during the years 1913 to 1919. These dots generally fall on the earthquake zone which runs from Mexico and the Antilles through the northern Mediterranean countries and Asia Minor into the Pamirs, Turkestan, the Himalayas, Assam and the Indian Ocean.

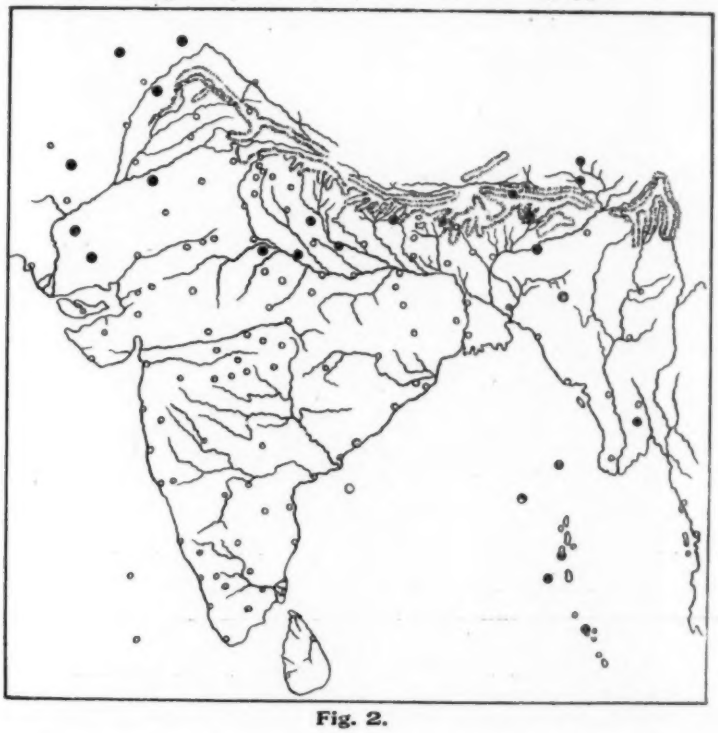


Fig. 2.

2. INSTRUMENTAL RECORDS.

Most of the seismographs in India failed to record faithfully the ground movements produced by the earthquake. The violent movements at Calcutta threw out of action all the seismographs at that Station. At Agra, the Milne-Shaw seismograph failed to work on account of the coupler (connecting the mirror with the boom) having been thrown off, but the Omori-Ewing seismograph recorded a part of the shock until the more violent movements damaged the instrument. At Bombay, the coupler of the E-W component of the Milne-Shaw seismograph was thrown off immediately on the arrival of the primary waves and of the N-S component on the arrival of the secondary waves. A fairly good record was, however, obtained with the seismograph of the Omori-Ewing type. Even as far south as Kodaikanal, the Milne-Shaw seismograph was thrown out of action on the arrival of the secondary waves.

The record obtained at Bombay with the Omori-Ewing instrument is reproduced in Fig. 3. This record is remarkable in many respects. The amplitudes of the primary and secondary waves are comparatively feeble, but the surface waves sweep from one end of the record to the other and are characterised by a very complex type of motion; the record looks as if it has been

written by a shaky hand. A part of the complexity must have arisen on account of the pendulum banging against the stops on either side. Another characteristic feature is the long duration of the violent motion associated with the surface waves lasting for nearly 5 minutes. Being an undamped pendulum, the periods of primary and secondary waves shown by the record are roughly equal to its free period. The periods of the primary waves recorded by the N-S component of the Milne-Shaw seismograph (damping ratio 20:1) are, supposed by Turner, then the surface waves would become very feeble compared with the primary and secondary waves. Subsequent work by other writers has confirmed the general correctness of the method; the few cases of deep focus for which evidence has been advanced have all very feeble surface waves. The very great preponderance of the surface waves in the Bihar earthquake compared with the primary and the secondary waves clearly indicates that the disturbance originated in the crust very close to the earth's surface. This will also explain

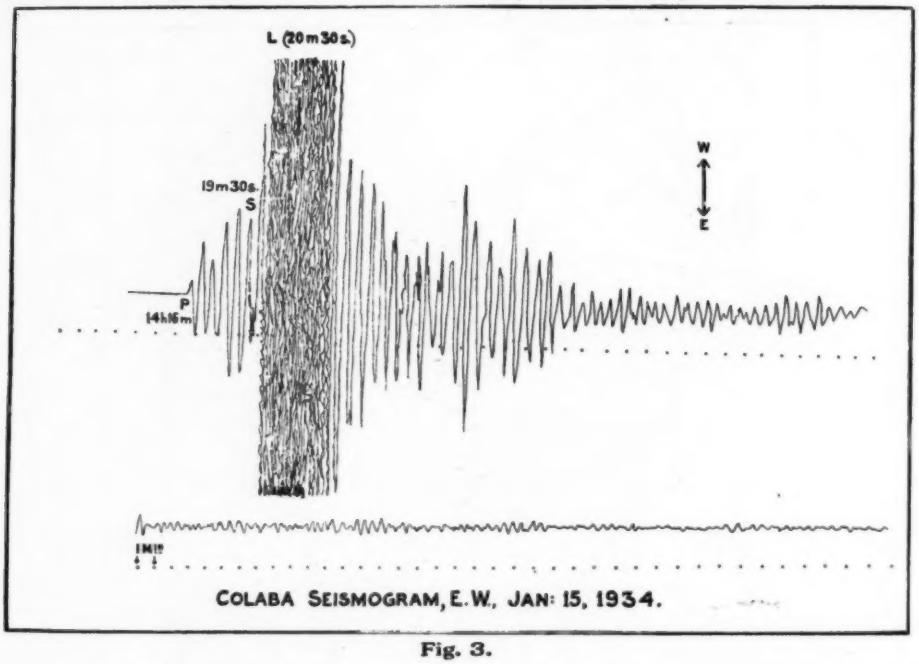


Fig. 3.

however, very quick being on the average about 3 secs. More or less similar features are shown by the record obtained at Agra with the Omori-Ewing instrument, which is reproduced in Fig. 4.

3. Nature of the Disturbance in the Epicentral Region.

A method of estimating the depth of an earthquake focus from the relative importance of the various phases in a seismogram was indicated by me in a paper "On the Depth of Earthquake Focus" (*Phil. Mag.*, **49**, January 1925). It was shown in that paper that if the depth of focus was as great as 300 km. or 400 km., as was why the shock was felt over such a wide area; for the amplitude of the surface waves decreases very slowly with distance, the law of decrease being (distance)$^{-\frac{1}{2}}$.

When accurate details of displacements of structures and dimensions of fractures caused by the earthquake are available, it will be possible to estimate roughly the strain involved and to calculate the velocity and acceleration of the ground in the epicentral tract. In the Assam earthquake of 1897, the velocity was about 16 ft./sec. and acceleration about 8 ft./sec.^{2}. From the description received, it appears that in the Bihar earthquake they were certainly not less than these figures. Fig. 5 gives a

photograph of the fissures in the pologround at Muzafferpore.

4. ORIGIN OF THE EARTHQUAKE.

Our knowledge of the origin of earthquakes is still very much controversial. We know, however, definitely that it is an elastic process, that, due to some cause or other, certain parts of the earth are subject to growing strain and when the ultimate strength of the rocks is reached, fractures occur along the zones of weakness, thus causing an earthquake and a relief of the strain.

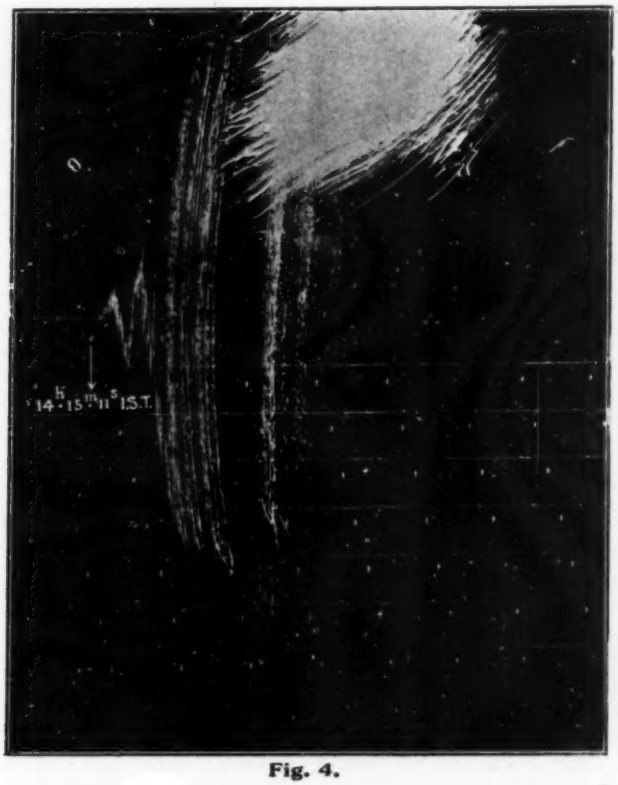


Fig. 4.

In explaining the cause of North Bihar earthquake one's thought is naturally directed to a disturbance of the isostatic compensation. Isostasy postulates that if we take a column of rock extending downward from the top of the Himalayan chain to a given level in the earth's crust, known as the compensation surface (about 120 km. below the mean surface of the earth) and another column of the same cross-section extending to the same level under the plains of North Bihar, then both columns should have the same weight. Even if this is the case at any time, we should expect the conditions to change; for rain, wind, glacier, etc., are continually moving rocks from the top of the mountains and distributing the materials of which they are composed over the plains. Nevertheless, according to geodesists the columns continue to weigh the same. This can only happen if compensation in some form is taking place, that is to say, there is an inflow of rock into the mountain column and an outflow from the plain column. Such cold flow of rocks must produce enormous strain on the surrounding portions. When the ultimate strength has been reached, and a relief of strain has occurred, a lifting of the mountain would be the natural result.

All evidence hitherto collected indicates that isostatic compensation holds for large areas, such as a continent but doubts have been expressed as to whether it holds for small areas as well, and these have been

strengthened on account of various gravity anomalies. It has been found that "g" is in excess on mountain ranges and in defect in valleys and at the foot of mountains. Recent observations in India have confirmed this result; it has been found that gravity is particularly in defect in North Bihar. This result is apparently exactly opposite to what is given by the theory of isostasy. It suggests that the materials in North Bihar, at any rate, in the upper layers, are of very low density and consequently there is probably an underloading. The region would therefore tend to rise up and would thus introduce a considerable strain at the junction between the mountain and the plains. It is, however, difficult to understand how the strain so introduced grows with time and reaches the elastic limit.

With regard to the gravity anomalies, Sir S. G. Burrard has said, "I have often met with gravity anomalies which seemed in opposition to Pratt's view, but after further detailed investigation these anomalies have been actually found to confirm him." It is not known to what depth the alluvium in the Gangetic plain extends and to what extent it is compressed in the lower layers. It is conceivable that the low density is confined to the surface layer and below that there is higher and higher density as we go down and that, therefore, in spite of the gravity anomaly the compensation holds. Indeed Burrard takes anomalous densities into account, and derives depths which will explain the observed facts, on the assumption that the compensation is perfect.

Fig. 5.

Denoting the four important seismic regions in the Himalayas, namely, Assam, Nepal, the Punjab and Kashmir, by the letters A, B, C, D, the great destructive shocks, as has been pointed out in a recent issue of "Nature" occurred in the following order:

D. 1828	C. 1832	B. 1833	A. 1869
D. 1885	C. 1875	B. 1869	
	C. 1905	B. 1934	A. 1897

That is to say, a continuous migration from D to A and back again to D, followed by an oscillation to the east in 1897, and back to the north-west in 1905, and ending in the

intermediate region in the present year. This would rather support that the earthquake shock has successively shifted to the region where the isostatic compensation has been disturbed to the maximum extent as years have passed on.

The earthquake occurred on a new moon day. At the time an atmospheric cold wave was also passing over the region. Some writers have pointed out that the influence of the planets or the disturbance of the atmospheric pressure may have been the immediate cause of the earthquake. It is known that the action of the sun and moon on a new moon day produces maximum "body tide" in the elastic solid material of the earth. Because of the coincidence, it is difficult to dispute the statement in this particular instance, that the "body tide" or the variation of load due to pressure may have acted as a 'trigger' in producing a sudden release of strain. No relationship has, however, been definitely traced between earthquake and atmospheric pressure or 'body tide' in the earth.

If the disturbance of the isostatic compensation is the cause of these earthquakes, it is clear that similar tectonic earthquakes will occur again in some region or other of the Himalayas, may be after the lapse of some years. We must, therefore, in rebuilding our cities take special steps to have earthquake-resisting structures and provide each important building, if possible, with an earthquake warning instrument, such as a simple pendulum, so adjusted that it will make an electric contact immediately on the incidence of the earthquake and work bells warning all residents to leave the building forthwith.

Dimitri Ivanowitsch Mendeleeff (1834–1907).

THIS year we celebrate the centenary of the birth of Dimitri Ivanowitsch Mendelèeff, who was born on February 7th, 1834 (N. S.). He will ever have an honoured place in the roll of famous chemists, since on the Periodic Law which he enunciated is based much of our modern classification of the chemical properties of matter, and of our knowledge of the electronic structure of atoms.

Mendelèeff was educated at his native place, Tobolsk, and at Leningrad, where he was appointed to a University Chair in 1866. He resigned his post in 1890, consequent on a difference with the University authorities, who found his independence of spirit something of a nuisance. In 1893 he became Director of the Bureau of Weights and Measures, a post which he held until his death at Leningrad on February 2nd, 1907 (N. S.).

Ever since the discovery of a range of chemical elements, efforts had been made to classify them in groups possessing similar chemical properties. No satisfactory result was achieved, however, until, in 1869, Mendelèeff communicated to the Russian Chemical Society his first periodic table and an enunciation of the Periodic Law according to which "the elements arranged according to the magnitude of atomic weights show a periodic change of properties". For the first time it was clearly recognised that the fundamental periodic property of the elements is valency. In 1871 Mendelèeff published his improved form of the Periodic Table, practically as we know it to-day. The main difference is that now the arrangement of elements is according to the atomic number to which, however, the atomic weight usually corresponds. Where the correspondence ceases we obtain the few anomalies in the Table, which so puzzled chemists who knew nothing of nuclear charges, nor of the existence of isotopes.

In 1871 Mendelèeff from a consideration of the gaps in the Periodic Table made his well-known prediction of the existence and properties of "eka-boron", "eka-aluminium", and "eka-silicon". In 1875, 1879 and 1886, there were discovered, respectively, gallium, scandium and germanium which confirmed these audacious predictions, and finally established the fundamental importance of the Periodic Law.

Mendelèeff was also led to question the correctness of the atomic weights assigned to certain elements as they did not correspond with the Periodic Law, and here again his statements were justified by further work.

One other achievement of the Periodic Law may be mentioned. It could not have been used to predict the existence of elements of zero valency. But when one member of the group (argon) had been discovered, it was clear that other elements similar in type

must be sought and their discovery was not long delayed.

The allocation of the rare earths was for years an apparent defect in the application of the Periodic Table. Mendelèeff considered that their installation should be deferred until their properties were better understood. We now know that these elements arise from the fact that at a certain point in the series of elements, each electron added to the system to balance unit increase in nuclear charge, goes to complete inner levels and leaves unchanged the outer valency electrons on which the chemical properties of the elements chiefly depend.

Although the Periodic Law was his outstanding contribution to chemical science, Mendelèeff did much work in other fields. His printed publications total 262. These include communications on physical and chemical subjects, books, pamphlets, reports and newspaper articles relating to exhibitions, to Russian industries, to weights and measures, to education, to art, and to spiritualism. He carried out a long series of experiments on the thermal expansion of liquids. His definition published in 1861 of the absolute boiling point of a liquid as the temperature at which cohesion and heat of vaporisation vanish, and the liquid vaporises irrespective of pressure and volume anticipated Andrews' conception of the critical point. He also directed a number of investigations on the densities of solutions, particularly mixtures of alcohol and water, sulphuric acid and water, and of salt solutions. He gave a good deal of attention to the subject of the elasticity of gases, and to the nature and origin of petroleum.

After his Periodic Law, however, he is best known for his famous *Principles of Chemistry* which has gone through many editions in various languages. In English there are three editions of which the last (1905) is from the seventh and best complete Russian edition (1903). The book is remarkable not only for its text which deals with inorganic chemistry, but also for the voluminous notes which testify to the enquiring spirit of the writer and the restless activity of his mind. As a teacher these same qualities of originality and freshness made him one of the greatest of his time. He had a talent for arousing a desire for knowledge, and students from all faculties of the University thronged his lectures.

We know more of the Periodic Table than ever Mendelèeff knew. We look to greater knowledge to a table which will express the purely nuclear properties of atoms. In 2034 when once again returns the centenary of the birth of this great chemist, knowledge of the periodic table will be assuredly deeper and more profound than the knowledge we possess to-day. But time will not dim nor the advance of knowledge obscure the memory of one, who in the early days of modern chemistry, by sheer native genius and application, laid the foundations of possibly the most important generalisation known to chemical science.

Ernst Haeckel (1834–1919).

ZOOLOGISTS will also remember that this year marks the centenary of another great figure, Ernst Haeckel. Born at Potsdam he was educated in various universities, and one of the three degrees of doctorates that he held was that of Law (an honorary degree) in addition to his qualifications in Philosophy and Medicine. In 1854 he came under the influence of J. Müller in Berlin. Müller left a remarkable impression on Haeckel and in 1858 he commenced to practise medicine like his contemporary Gegenbaur. Soon after the death of Müller which came as a shock to young Haeckel, the latter commenced the study of Radiolaria of the Italian coast and later returned to Berlin. It was about this time that Haeckel came into contact with the famous and perhaps the then revolutionary book, the "Origin of Species" by Darwin. He says 'It profoundly moved me at the first reading.' On the other hand, the other German Biologists were opposed to this trend of thought and regarded the book as 'absolute nonsense'. Haeckel therefore happened to be the pioneer in ushering Darwinian ideas in Germany.

He was appointed Professor of Zoology in Jena, a post which he held for a very long time. Amongst his memoirs must be mentioned the report on the Radiolaria, on Siphonophora, the deep-sea Keratosa, Planktonic studies, and Cell-Theory. The crowning glory of Haeckel was his lecture at the International Congress of Zoology at Cambridge in 1898, where he spoke about the ever interesting subject—The Evolution of Man.

Professor H. E. Watson, D.Sc., F.I.C., M.I.Chem.E.

THE impending departure of Dr. H. E. Watson from the Indian Institute of Science, Bangalore, is widely regarded by men of science as an unrelieved misfortune for this country. Particularly among his past and present colleagues and students will the resultant breach in continuity of chemical work at the Institute be deprecated, because it is only by them that his unrivalled contribution to the achievement of that foundation can be truly estimated. Having been appointed assistant professor of general chemistry at the opening of the laboratories in 1911, and thereafter becoming professor (1916), he has been increasingly identified with the Institute's growth, and it may be claimed that his own share in its development is unexcelled.

This claim is not founded on length of service alone, but is based on the more steadfast footing of meritorious devotion to the interests of graduates coming under his guidance. That has been shown primarily by the rigid orthodoxy of his training methods, his unswerving adherence to the principle of scientific responsibility, and his unflagging industry. A further benefit derived by those in laboratory association with Dr. Watson follows from his extraordinary skill in the less conventional aspects of experimentation, enabling him not only to elaborate complicated apparatus in glass and quartz required for the study of rare gases; but, by his highly trained senses of sight and hearing to detect faults and suggest uncanny improvements in the design and construction of appliances for his physicochemical researches and radio-work. It is impossible to estimate the advantage to a developing scientific mind offered by direct laboratory contact with so subtle a craftsman.

A survey of Dr. Watson's early career reveals the promise that has been amply fulfilled, and excludes him from that band of successful men who have been the despair of their schoolmasters. At eighteen he left Marlborough (in 1904) laden with prizes and scholarships, gained principally for languages, mathematics and science. Although these included a mathematical scholarship at Trinity College, Cambridge, he preferred to enrol himself at University College, London, with Sir William Ramsay, among whose bright young collaborators were M. W. Travers, F. G. Donnan and E. C. C. Baly. To this association may be traced his early interest in the spectroscopy and physical properties of the rare gases helium, neon, krypton and xenon; it explains his later developed facility in glass-blowing, for which Ramsay was famous, and it was ultimately responsible for his joining the Institute, at whose foundation Sir Dorabji Tata depended largely on the judgment of Ramsay in selecting a staff. Meanwhile, however, Dr. Watson had continued at University College the course of academic distinction presaged by his Marlborough career, gaining a succession of prizes and scholarships that culminated in the 1851 Exhibition. While holding this he worked at Berlin with Nernst on the specific heat of gases at low temperatures (1909) and at Geneva with Guye (1910), concluding his *Wanderjahre* at the Cavendish Laboratory, Cambridge (1911) with Sir J. J. Thomson.

It is difficult for those more recently familiar with the laboratories at Hebbal to realise that 25 years ago the Institute was merely a name attached to an untenanted estate. The initial staff were veritable pioneers, charged with the dual task of establishing physical equipment and ethical tradition. Dr. Watson's material contribution to that labour has been very substantial indeed. It is witnessed by the range of

active laboratories growing under his direction, and more particularly, for reasons indicated later, by the workshop, machine-room and chemical engineering appliances attached to his department. Even more valuable to the students, though intangible, has been his constant example of intellectual honesty, characterising not only his methods of training but his conduct of research. In an age of hasty over-publication, his restraint has offered a sound corrective to an unwholesome tendency.

Allowing for this self-imposed factor, the volume of his published researches is most impressive, and illustrates his broad outlook on scientific problems. It embraces work on the kinetics of reaction and equilibrium, photochemistry, the colloidal state, inorganic changes, electrical properties of matter, supersonics, reactions at high temperatures, and further developments of his earliest observations on gases and spectroscopy in the direction of atomic and sub-atomic chemistry. Particularly his work on dielectric coefficients of gases has reached a very high standard, revealing new technique, and a conclusiveness regarding the structure of simple molecules not attained by earlier workers. In association with Dr. J. J. Sudborough, who retired from the Institute in 1925, he had elaborated methods for analysing the fixed oils and fats abounding in the natural products of this country, and these have now been applied to a very wide range of seeds.

It is commonly observed that a mind strict in academic principles and fruitful in their development, is disinclined to attack industrial problems. Dr. Watson provides a rare contradiction of this doctrine, and his unfailing interest in various branches of Indian chemical industry has been a fortunate circumstance for the Institute. Conspicuous among the subjects engaging his attention have been the extraction of oil from sandalwood, soap-manufacture from local raw materials, utilisation of wood-distillation products, manufacture of white lead, chromates from Indian chromite, refining of crude saltpetre, isolation of thymol and caffeine, catalytic production of ether, anhydrous alcohol for power purposes, chromium electro-plating, vegetable oil refining and hydrogenation. Some of these inquiries have brought definite advantage to local industries, and all have served to link a stimulus of potential utility to the investigations promoted in his laboratories.

Under his direction there has been affixed to the work of the department a very definite industrial complexion, of which the main features are: (1) examination of raw materials for manufacturing possibilities, (2) adaptation of known processes to Indian natural resources, (3) investigating the technical details of processes incompletely specified, (4) devising new processes, and (5) solution of manufacturing difficulties. These have involved many thousands of exact analyses of natural and manufactured materials, providing numerous graduates with experience in the application of analytical principles, and sometimes leading them to congenial employment in branches of industry for which they may have developed an aptitude. Dr. Watson may also be grouped with the authors of the Bunsen burner and the Dewar flask as an unrewarded public benefactor, having invented the neon lamp in 1910 and even then recognising its decorative and advertisemental possibilities, without having derived any pecuniary gain therefrom. He has been for many years a zealous worker in the field of wireless, and was for some time engaged in experimental transmissions of radio-telephony from his well-known station V U 2 B F. He has also devoted much attention to the design and construction of wireless receivers and of audio-amplifiers for gramophone reproduction.

There are many other aspects of Dr. Watson's long and fruitful association with the Institute which will increase the sense of loss incurred by his departure. To his committee-work he brought a discriminating perspicacity which was of the utmost value to his colleagues; and the library, now the best of its kind in this country, has benefited widely by his constructive power of selection. His regular presence at the weekly colloquium was always associated with helpful contributions to the discussion, while his own addresses were invariably attractive and informing. In him the Gymkhana Club found one of its warmest and most loyal supporters, and successive generations of students will pleasurably recall many happy evenings at his own house, when the exercise of his generous hospitality was unreservedly shared by Mrs. Watson.

The South Indian Cyclone of December 13-16, 1933.

By Dr. S. K. Banerji, D.Sc.

IT is now more or less definitely recognised that when two different air masses meet each other along an extensive 'front' and then rise one over the other, we get the most favourable conditions for the formation of storms. In the Indian seas such favourable conditions frequently develop during the periods of advancing monsoon (April to June) and of retreating monsoon (October to December). The north-east and south-west monsoons are opposing air currents with altogether different properties and when they meet face to face the north-east current usually undercuts the south-west and we get a discontinuous surface with very little slope, often ill-defined at the sea level, but more or less well-marked at higher levels. The initial position of the discontinuity varies with the strength of the two currents; in the Bay of Bengal the position moves northwards during advancing south-west monsoon and recedes southwards during retreating south-west monsoon with the march of the season. In December, therefore, storms generally form in the south Bay of Bengal and travel along the discontinuity in some westerly or north-westerly direction. The cyclone which devastated South India in the middle of last December formed over the south Bay of Bengal east of Ceylon, first as a depression and then gradually intensified into a 'cyclone' with a belt of hurricane winds.

Although a considerable mass of information has been collected in regard to tropical cyclones, our picture of the physical processes involved in their production, maintenance and movement is by no means complete.

The great difficulty in the application of the theory of formation of vortices on the surface of a discontinuity to storms has been the enormous dimensions of the latter. An ill-defined discontinuous surface between two different air masses, with very little slope to the ground surface and with no marked temperature contrast, would give rise to waves (or vortices) of very large wave-length but nothing so large as the diameter of a tropical storm. It is, however, conceivable that once a vortex has developed, whatever its dimensions, it will tend to draw into its circulation, aided by earth's rotation, a wider mass of air and grow in size. On the other hand, there are facts, such as the 'calm' centre of a tropical cyclone, which are difficult to explain except on the basis of the older theory, which conceived it to be a revolving fluid with a strong upward rush of air in its central region. The enormous release of energy, which condensation associated with such a process would give rise to, would furnish a more natural explanation of the belt of hurricane winds and its maintenance. The 'revolving fluid theory' will not, however, explain the asymmetrical structure of a tropical cyclone. On the whole, therefore, it would seem that both processes come into play in the generation and maintenance of tropical cyclones.

The Madras Cyclone of December 13-16 seems to have originated in the form of a 'wave' of at least 700 miles wave-length on the discontinuous boundary between the north-east and south-west monsoon currents and to have gradually developed into a tropical cyclone. There was a marked strengthening of the north-east monsoon in the south-west Bay of Bengal on the 10th December and this came face to face with the south-west monsoon; the result was that conditions first became unsettled to the east of Ceylon on the 11th and then led gradually to the formation of a 'depression', with a definite cyclonic circulation, by the 12th evening, with its centre near Lat. 9°N., Long. 83°E. The depression intensified by the 14th morning into a severe cyclone, which moved north-westwards and crossed the coast near Cuddalore on the 15th evening. The upper air observations indicate that on the 13th the cyclonic circulation extended up to a height of 3 to 4 km. and on the 14th, 4 to 5 km. There is no definite information whether this cyclone had a 'calm centre', but very probably it had. The belt of hurricane winds had very probably a breadth of about 50 miles and a diameter of about 150 miles. As usually happens, on entering inland, the cyclone rapidly weakened and lay as a 'depression' over south-east Madras on the 16th. The depression filled up on the next day but induced unsettled conditions in the south-east Arabian Sea off Kanara; the unsettled conditions moved slowly northwards and became unimportant off Konkan on the 20th.

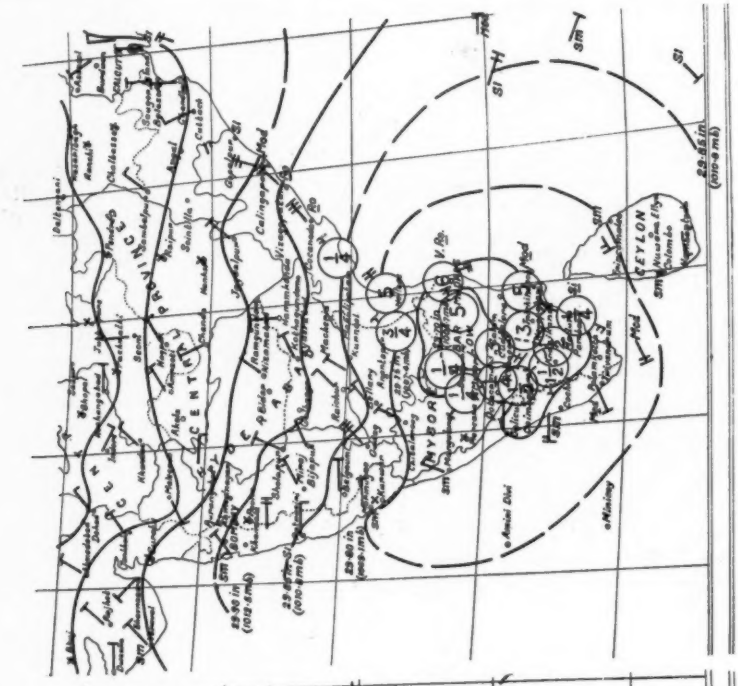


Fig. 3.
WEATHER MAP, DEC. 16, 8 A.M.

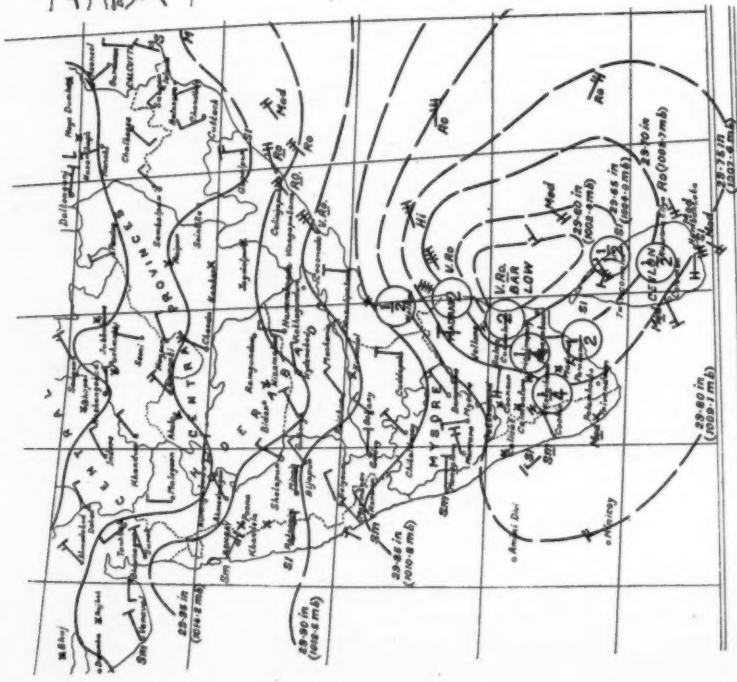


Fig. 1.
WEATHER MAP, DEC. 15, 8 A.M.

Fig. 5.
TRACK OF CYCLONE.

Fig. 2.
DEPARTURE OF 8 A.M.
PRESSURE OF DAY FROM NORMAL.
DEC. 15
(IN TENTHS OF AN INCH)

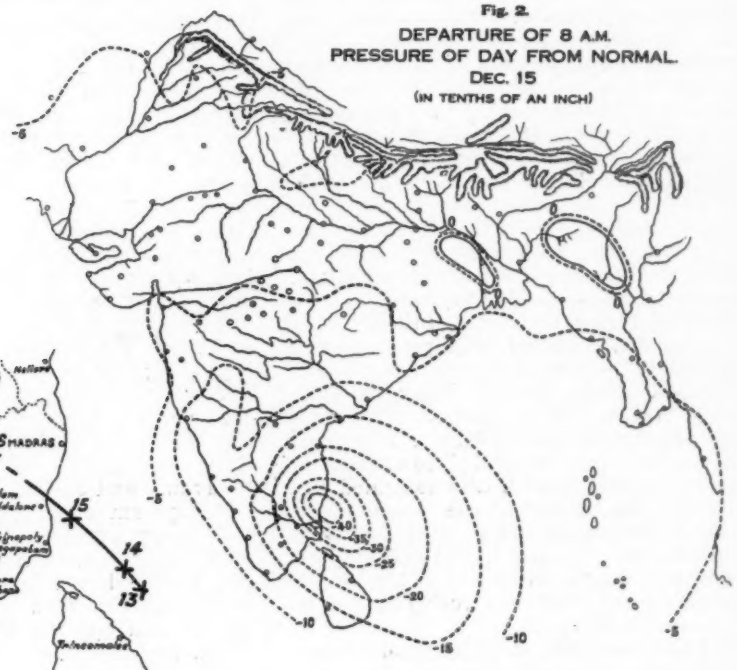


Fig. 4.
DEPARTURE OF 8 A.M.
PRESSURE OF DAY FROM NORMAL.
DEC. 16
(IN TENTHS OF AN INCH)

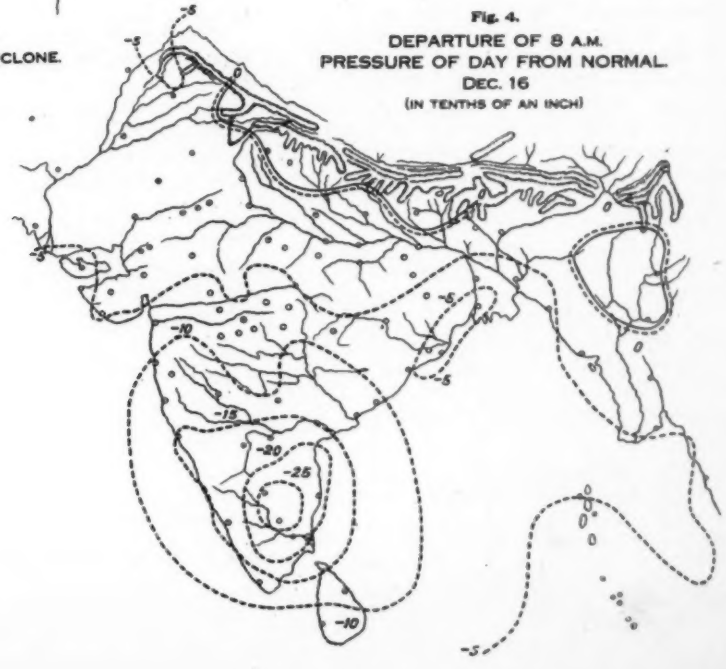


Figure 1 shows the weather map on the 15th morning at 8 A.M. The storm is seen to be near and approaching the coast. Fig. 2 shows that the depression of the barometer near its centre was at least half an inch. Actually, however, during the passage of the cyclone across the coast, the observations taken at Cuddalore indicated that the depression of the barometer at its centre was at least one inch. Fig. 3 shows the weather map on the 16th morning at 8 A.M. The cyclone had then entered inland; the figures within the small circles show that it had caused wide-spread heavy rain. Figure 5 shows the track of the centre of the storm.

The cyclone caused widespread rain in south-east Madras and Mysore between the 14th and 16th, rainfall being specially heavy in the Nellore, Madras, Chingleput and Arcot districts. With the northward movement of the unsettled conditions off the west coast, rainfall also extended into Kanara, the Konkan, the Deccan, the north Madras coast, the Central Provinces, Central India, east Rajputana and Gujarat.

The following is an account of the weather experienced at Cuddalore during the passage of the cyclone:—

"The cyclone caused wide-spread damage; at its height it caused a six-foot storm wave to sweep the coast in its vicinity. On the 15th at 10 A.M., barometer was 29·80 ins., wind was N.-E. of force 8, with fierce squalls of force 10. It remained steady at N.-E., gradually increasing until 2 P.M., after which it was blowing steady at force 10, with barometer 29·35 ins. The rainfall was negligible as the strength of the wind blew it into fine particles like sleet. At 4 P.M. the barometer had fallen to 29·12 ins., and between 5 and 6 P.M. it was 29·00 ins., when the wind had veered to the east, force being 11 with frequent terrific squalls rising to force 12. This easterly wind blowing direct from the sea caused a sudden rise of water in an hour of about six feet above 'high water' level inundating the whole of the lower ground on the sea coast. The rivers Gadillam, Uppanar and Paravanar resembled a rough sea. The barometer rose to 29·15 ins. and the wind shifted to east-south-east at about 8 P.M. still blowing at force 11 with frequent squalls of force 12. At 11 P.M. wind was south-east, of force 11, but easing rapidly. The storm wave receded as rapidly as it rose till by midnight it had more or less completely receded. Heavy rain fell during the night of the 16th and there was high flood in both the rivers Paravanar and Gadillam."

Negapatam experienced from 2 A.M. on 15th heavy squalls and continuous rain, the wind coming first from north-west, with high and confused sea and heavy swell from north-east, the wind subsequently backing to west and later to west-south-west until 2 P.M. and then backing to south-west and south when the storm crossed the coast north of the port.

Heavy rain and strong winds associated with the cyclone caused severe floods and damage to telegraph and railway lines as well as to crops and property in the Madras, Chingleput and Arcot districts; some lives were lost and a train was thrown off the rails near Cuddalore.

Letters to the Editor.

A Preliminary Note on the Embryosac Development of *Callistemon linearis*.

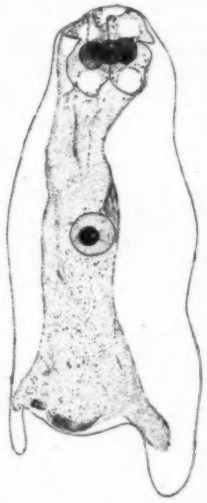
A SEARCH through the literature reveals the rather surprising fact that the family *Myrtaceæ* has been almost entirely neglected so far as their embryological development is concerned.

In spite of its richness, however, the only investigated cases so far recorded as cited by Schnarf[1] in his recently published admirable book are by Braun,[2] Cook,[3] Tiwary,[4] and Greco.[5] More recently Pijl[6] has published an account of his investigations on a few species of *Eugenia* from Java.

In *Callistemon*, the archesporium is hypodermal. It is not always restricted to a single cell, accessory archesporial cells being found in many ovules. Only one, however, pursues its development further. These accessory archesporial cells sometimes increase by multiplication, the daughter cells continuing to show the prominent archesporial features. The primary archesporial divides into the primary parietal and the primary sporogenous cell, the former undergoing further divisions to give rise to a parietal tissue. This results in the sporogenous cell becoming sunk about three or four cells deep in the nucellus.

The primary sporogenous cell becomes the megaspore mother-cell directly. In megasporogenesis a T-shaped tetrad is formed by two successive nuclear divisions. These divisions may or may not be simultaneous. When not simultaneous, it is the division in the cell on the micropylar side that is delayed. There is evidence also of a tendency towards the elimination of the wall-formation between the daughter nuclei. This may proceed so far as even to eliminate altogether the nuclear division in this cell.

The chalazal megaspore functions, developing into an 8-nucleate embryosac. The antipodals, however, seem to degenerate mostly quite early, since only degenerating ones are found in many ovules. The egg is as big as the synergids. In most cases it may even be smaller. The evidence so far indicates that the two polar nuclei fuse somewhere near the middle of the sac producing quite a prominent secondary nucleus (*vide* figure). Travelling to the micropylar side this nucleus later takes up its position close to the egg.



Almost mature embryosac of *Callistemon*.

The synergids during their development produce prominent beaks. The absence of these in some well-developed synergids indicates that this feature is lost at a later stage. Such hooked synergids have also been reported for other plants.[7,8,9] Their discovery in *Callistemon* adds one more name to the list.

The present investigation forms the first of a series of papers which it is intended to publish on the comparative embryology of the *Myrtaceæ*. The material has already

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[1] Schnarf, K. "Vergleichende Embryologie der Angiospermen." Berlin, 1932.

[2] Braun, A. "Uber Parthenogenesis bei Pflanzen." (*Abh. Ak.*, Berlin, *phys. Kl.* 1856.) 1857.

[3] Cook, M. T. "Notes on Polyembryony," *Torreya*, **7**, 113–117, 1907.

[4] Tiwary, N. K. (*a*) "On a peculiar mode of Germination of the seed in *Eugenia Jambolana*." *Proc. Ind. Sci. Congr., Calcutta*, 1921.

(*b*) "A preliminary note on the structure of the embryosac and the origin of the embryos in *Eugenia Jambolana*." *Proc. Ind. Sci. Congr., Benares*, 1925.

(*c*) "Development of the Embryosac in *Eugenia Jambolana*." *Proc. Ind. Sci. Congr., Bombay*, 1926.

(*d*) "On the occurrence of Polyembryony in the genus *Eugenia*." *Journ. Ind. Bot. Soc.*, **5**, 1926.

(*e*) "Further observations on the seeds and seedlings of *Eugenia Jambolana*." *Journ. Ind. Bot. Soc.*, **8**, 1929.

[5] Greco, R. (*a*) "Notizie preliminari sull'embryologia e la cariologia del *Myrtus communis*." *Nuovo giorn. bot. Ital.*, **36**, 1929.

(*b*) "Embryologia del *Myrtus communis*," *Ibid.*, **38**, 1930.

[6] Pijl, L. van Der. "Uber die Polyembryonie bei *Eugenia*." *Rec. des. Trav. bot.*, neerlandai, **31**, 1934.

[7] Rocén, Th. "Zur Embryologie d. Centrospermen. Diss." Uppsala, 1927.

[8] Maheshwari, P. "Contribution to the Morphology of *Boerhaavia diffusa*." *Journ. Ind. Bot. Soc.*, **8**, 1929.

[9] Bhargava, H. R. "Contribution to the Morphology of *Boerhaavia rependa*." *Journ. Ind. Bot. Soc.*, **11**, 1932.

been accumulating. The detailed account will appear elsewhere.

N. K. TIWARY.
V. S. RAO.

Benares Hindu University,
January 25, 1934.

Density of Propicnic Acid Solutions in Water.

IN an experiment for the observation of the Faraday rotation of fatty acid solutions in water the density of the solution of propionic acid for different concentrations was determined as no detailed result for this is given in the *I.C.T.*[1] Some previous works, however, are referred to in those tables, but as far as the old literature could be consulted no systematic and exhaustive work seems to have been done in this direction. Thus Wilsdon and Sidgwick[2] give experimental values for only three low concentrations (from 1·945 to 10·28% of acid by volume) together with three other interpolated values for about the same range. Drucker[3] has also given results for eight different concentrations low and high, of which only two are for concentrations beyond 50%. Thus, it was necessary to make some fresh and systematic determinations.

All measurements were made at 25°C. and the variation of temperature was about ± ·02. A specific gravity bottle of 50 c.c. capacity was employed for density determination. The results are given in the table below (Table I) and also plotted in the graph. It is found that the density of the solution goes on increasing with the addition of the acid, but after reaching a maximum for about 51·2% of the acid (by volume), it decreases gradually. It is to be noted that the maximum density occurs at about a concentration when the acid and the water are mixed in equal quantities by weight. The phenomenon is also supported by the fact that in observing the Faraday rotation, the intensity of the light passing through the solution considerably diminishes at this concentration in comparison with concentrations higher and lower.

In the graph dots give the results of the present experiment and the small circles the Drucker's values. Of the latter, the value of the density for 74·01% of the acid (by volume) is rather high.

The Faraday rotation of the solution, however, does not show any maximum but goes on increasing with increase in the percentage of water, although it does not conform to the Schonrock-verdet mixture rule.

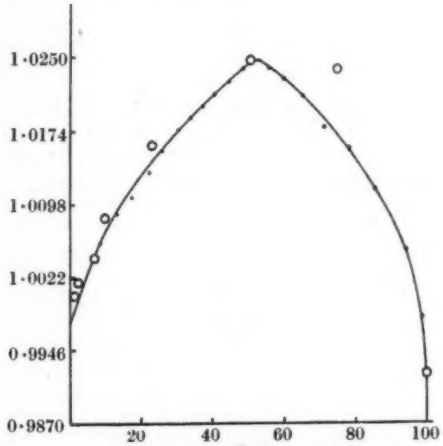

TABLE I.

Concentration % by volume	d^{25}_4	Concentration % by volume	d^{25}_4
7·098	1·0060	48·08	1·0244
11·36	1·00862	52·91	1·0250
15·91	1·01094	58·21	1·02370
20·69	1·01354	64·04	1·0222
24·84	1·01584	70·47	1·0186
29·85	1·01784	76·95	1·01624
32·84	1·01921	83·97	1·01204
36·11	1·02046	92·39	1·0058
39·73	1·02190	98·01	0·9882
43·70	1·02310		

B. N. CHUCKERBUTTI.

Calcutta,
January 31, 1934.

The Number of Microsporangia in each Stamen in *Asclepiadaceæ*.

THE available literature on the family, *Asclepiadaceæ*, discloses the fact that this family is characterised by the presence of only two microsporangia in each stamen. Frye,[1] however, expresses his doubt on this fact and appears to hint at the possibility of the existence of four microsporangia

[1] *I.C.T.*, 3.

[2] Wilsdon and Sidgwick, *J. Chem. Soc.*, **103**, 1959.

[3] Drucker, *Zeits. f. Phys. Chemie*, **52**, 641.

in the small group, Secamoneæ of Synancoideæ[2] where the pollinia in each half anther are paired and the parts adhere closely. With this object in view the study of the following eight genera, each being represented by a single local species, was taken up. Three genera out of eight, namely, Hemidesmus, Cryptostegia and Cryptolepis, exhibit the presence of four sporangia in each stamen.

Table to show a few important characters in the Floral Organisation of the Species.

Name of Genera	Name of Species	Arrangement of Pollen-mother-cells	Arrangement of Tetrads	Number of Sporangia in each Stamen	Organisation of Pollinium
1. Calotropis ..	*C. gigantea* ..	Radial ..	Linear ..	Two ..	Well organised
2. Dæmia ..	*D. extensa* ..	Do. ..	Do. ..	Do. ..	Do.
3. Holostemma ..	*H. rheedei* ..	Do. ..	Do. ..	Do. ..	Do.
4. Pergularia ..	*P. pallida* ..	Do. ..	Do. ..	Do. ..	Do.
5. Dregea ..	*D. volubilis* ..	Do. ..	Do. ..	Do. ..	Do.
6. Hemidesmus ..	*H. indicus* ..	Do. ..	Do. * ..	Four ..	Do.
7. Cryptostegia ..	*C. grandiflora* ..	Irregular ..	Tetrahedral	Do. ..	Loose mass
8. Cryptolepis ..	*C. buchanani* ..	Do. ..	Do. ..	Do. † ..	Do.

Whether the sporangia in each case mentioned above are evolved at a later stage of development from a common mass of archesporium by the interjection of plates of sterile tissue, as in Lemna minor[3] or independently from the beginning, is a question still to be solved in some cases. Their independent origin in Hemidesmus, Dæmia, Pergularia and Cryptolepis has, however, been well established, while in the remaining cases their history has been definitely traced upto the very early stages of pollen-mother-cell development. Again, so far studied, neither there is any indication of suppression nor fusion of sporangia at any stage of development from four to two in those cases where two sporangia in each stamen is a rule. From the table given above it may be concluded then: (1) that there are some genera in the family, *Asclepiadaceæ*, which possess four microsporangia in each stamen; (2) that for the organisation of pollinium the radial arrangement of pollen-mother-cells and consequently the linear tetrads are necessary; (3) that the arrangement of tetrads and the number of sporangia are not in any way correlated because *H. indicus* possesses four sporangia while *D. extensa* and others only two in each stamen, yet the linear tetrads exist in the two groups. Again, *H. indicus* and *C. grandiflora* exhibit four sporangia in each stamen and yet the tetrad arrangement is different in both the cases, *i.e.*, linear and tetrahedral respectively; (4) that for the organisation of pollinium the presence of linear tetrads as has been already said above is necessary and mechanical principle also demands this, hence with some variations here and there, as in *H. indicus*,* all members belonging to the group, *Cynanchoideæ*, where pollinia are well organised, will exhibit linear tetrads, irrespective of their number of sporangia in each stamen.

Thanks are due to Professor M. Owen, Head of the Institute and Dr. R. L. Nirula, Head of the Botany Department, for all sorts of facilities they have been giving me for the completion of my work on *Asclepiadaceæ*.

R. H. RICHHARIA.
Department of Botany,
College of Science,
Nagpur, C.P.
January, 1934.

* Besides the presence of usual linear tetrads in *H. indicus* there are other variations as well, such as T-shaped and double ‡-shaped tetrads, etc. A paper on this will shortly appear elsewhere.

† In advanced stages of development the partition between the two adjacent microsporangia, in *C. buchanani*, breaks down resulting in a single loculus. In advanced conditions, therefore, the stamen in this species contains only two cavities.

A Few Important References.

[1] Frye, T. C. "Development of the pollen in some *Asclepiadaceæ*." *Bot. Gaz.*, **32**, 325, 1901.

[2] Willis, J. C. Cambridge Biological Series: "Flowering Plants and Ferns," 1925.

[3] Coulter and Chamberlain. *Morphology of Angiosperm*, **2**.

The Physics of Olfaction.

NUMEROUS workers since Liégois and Prevost have tried to formulate a physical basis for smell, Teudt's (1919) electronic theory being one of the most recent. It is unlikely that a satisfactory theory would be derived from a consideration of physics alone, owing to the psychological and other factors intimately bound up with the oldest and most neglected of our senses. However, it is not correct to say that no physics of olfaction exists at all.

In 1904 Berthelot suggested that the lower limit of the number of molecules perceptible by smell lay between 10^8 and 10^{11}. Zwaardemaker and Heyninx arrived independently at a figure of the order of 10^9. Lord Rayleigh, following Töpler and Boltzmann, equated the energy of minimal stimuli of sound and light at about 40 ergs, which, in the case of sound, can be expressed as a change of compression of the order of 10^{-10} atmospheres. Assuming an olfactory inspiration of about 1 cubic inch, this figure is of the same order as the smallest number of odorous molecules which require to be drawn into the nasal passage to excite the sense of smell, as I have shown in the *Perfumery and Essential Oil Record*, **17**, 1926, p. 176.

The quantity of odorous material perceptible to the nose may be inconceivably small when expressed in fractions of a milligram, yet be numerically large if regarded as a number of molecules. The molecules in a cubic inch of ordinary air would form a line many times longer than the circumference of the earth, if they were placed side by side, but a number of molecules perceptible by smell could be strung along a length of less than a meter. For comparison with the intensity of sound stimuli, it may be of interest to mention that a crowd of a hundred thousand persons would need to shout for an appreciable period to emit as much sound energy as would equal the heat in a cup of tea.

Tyndall suggested a theory of odour based upon the heat absorbed by odorous substances. Grijns in 1919, and the writer more recently, have shown that the heat absorption of essential oils can be referred almost entirely to an adventitious content of water. A physical investigation of odorous substances at the concentrations at which they are perceptible to the nose would require very delicate apparatus, as it would be necessary to deal with partial pressures of considerably less than a millionth of an atmosphere.

HUGH NICOL.

Rothamsted Experimental Station,
Harpenden,
February 6, 1934.

On the Development of the Intervertebral Ligament in Teleostean Fishes.

MACBRIDE[1] in summarising the observation of Ramanujam[3] on the development of the vertebral column of herring, states with reference to the formation of the intervertebral ligament that "the notochordal tissue intervening between the chorda centra projects as a series of gelatinous pads which are ultimately transformed into intervertebral ligaments". The various species of teleostean fishes that I have studied so far present, however, a different story altogether.

The sclerotomic cells aggregate round the notochord as perichordal sheath; soon after this, the perichordal sheath of the vertebral portions becomes osseous, while the intervertebral portions remain still membraneous (Fig. 1). Outside these membraneous intervertebral portions of the perichordal sheath, migratory connective tissue cells become arranged side by side into three bands and these enter the membraneous portions of the perichordal sheath (Fig. 2). I [2(a) & 2(b)] have shown how such migratory connective tissue cells enter through the intervertebral portions of the vertebral columns both in Urodela and Anura in order to form ophisthocœlous and procœlous vertebræ respectively. The middle band of the connective tissue cells situated at the intervertebral portions of the teleostean fishes, contributes to the formation of the intervertebral ligaments, whereas the two lateral bands of the connective tissue cells which ultimately become cartilaginous give rise to the formation of the two surfaces of the centrum. This sort of formation of the intervertebral ligaments

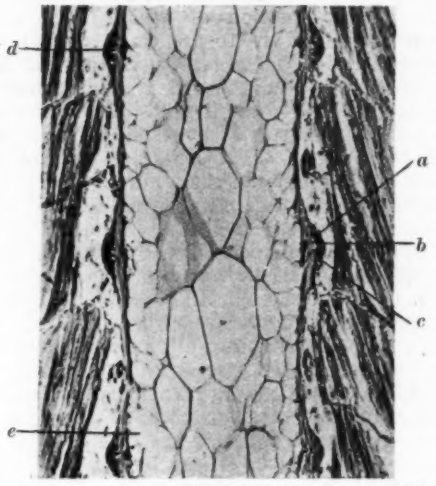

Fig. 1. × 185

A Photomicrograph of a frontal section passing through the middle region of the vertebral centra of *Ophicephalus striatus*, Bloch at 12 mm. stage showing the three cut ends of the connective tissue bands outside the bulging of the notochordal sheath in the intervertebral regions on either side of the notochord.

a, *b*, *c*—Cut ends of three bands of connective tissue. *d*—bulging of the notochordal sheath. *e*—notochord.

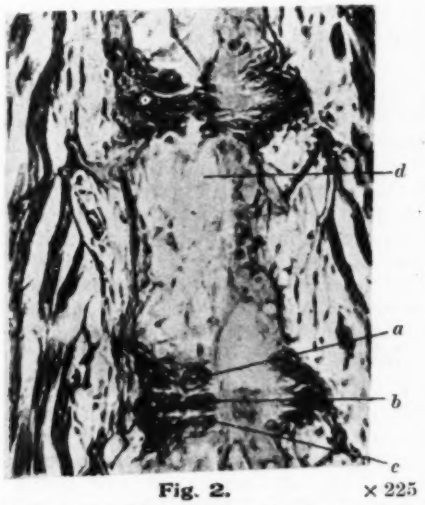

Fig. 2. × 225

A photomicrograph of a frontal section passing through the peripheri of the vertebral centra of *Ophicephalus striatus*, Bloch at 12 mm. stage showing the three bands of connective tissue cells in the intervertebral region.

a, *b*, *c*—three bands of connective tissue cells. *d*—notochord.

has also been traced by me in the vertebral columns of our house lizard and chick.

The statement of Ramanujam[3] is correct so far as the existence of the bulging of the notochordal sheath in the intervertebral region is concerned. The bulging which is due to the zone of growth of the notochord together with its sheath, is transferred from the vertebral to the intervertebral portions but this bulging of the notochordal tissue in the intervertebral region has nothing to do with the formation of the intervertebral ligament.

The details will be published elsewhere.

HIMADRI KUMAR MOOKERJEE.

Department of Zoology,
University of Calcutta,
February 8, 1934.

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[1] MacBride, E. W. "Recent work on the development of the vertebral column." *Bio. Review*, **7**, No. 2, April 1932, pp. 108-148.

[2(a)] Mookerjee, H. K. "On the development of the vertebral column in Urodela." *Phil. Trans. Roy. Soc. Lond.*, **B. 218**, 1930, pp. 415-446.

[2(b)] Mookerjee, H. K. "On the development of the vertebral column in Anura." *Phil. Trans. Roy. Soc. Lond.*, **B. 219**, 1931, pp. 165-196.

[3] Ramanujam, S. G. M. "The study of the development of the vertebral column in Teleosts as shown in the life-history of the herring." *Proc. Zool. Soc. Lond.*, 1829, pp. 365-414.

Colour of Cotton Flowers.

IN the course of an investigation on the chemical constituents of the different species of the *Gossipium* (cotton) a marked difference in colour was noticed between the petals of the Cambodia, a South Indian variety of *G. Hirsutum* on the one hand and those of Uppam and Karunganni, South Indian varieties of *G. Herbaceum* and *G. Indicum* respectively on the other. The former are pale being only cream coloured whereas the latter are bright golden yellow. It is found that this difference in colour cannot be explained as due to the nature or the quantity of the pigments present. Cambodia contains mainly Quercimeritrin whereas Uppam contains Gossipitrin and Karunganni an almost equal mixture of the two. It is known that there is a close similarity between the two flavanol glycosides in their tinctorial properties and experiments now show that the Cambodia petals contain a higher percentage of the

colouring matter than those of the other two.

In regard to the colour of cotton and other flowers A. G. Perkin (*J.C.S.*, 1909, 2181 and 2185; 1916, 146) has expressed the view that flavanols being present in general as glycosides which are colourless or nearly so, can themselves exert little or no colour effect and where a yellow colour is due to them it could be traced to their presence as a potassium or other salt. While the above remark about the feeble tinctorial properties of the glycosides is true in the case of the 3-glycosides like Rutin and Isoquercitrin, it does not seem to be applicable to Gossipitrin and Quercimeritrin which are not 3-glycosides. Total ash and potash contents of the petals and solubilities of the crude pigments of the three cottons mentioned above do not exhibit any marked differences. These results and the values of the pH of the cell sap from the petals do not support the metallic salt hypothesis for the colour differences. On the other hand colour reactions and dyeing tests using aqueous extracts of the fresh petals indicate that the bright yellow petals resemble 7-glycosides whereas the pale Cambodia petals resemble 3-glycosides. It is now therefore suggested that in the former the flavanol glycosides are present in the free condition, the colour effect being probably enhanced by favourable state of aggregation and that in the latter Quercimeritrin exists in some form of loose combination with some other organic body through the hydroxyl in the 3-position. Thus copigmentation which has been studied by G. M. Robinson and R. Robinson (*Biochem J.*, 1931, 1687; 1932, 1647) in connection with the anthocyanins seems to be an important factor in the case of colouration by anthoxanthins also. In the Cambodia flowers copigmentation apparently reduces the colour intensity. The details will be published elsewhere.

T. R. SESHADRI.

Andhra University,
Waltair,
February 8, 1934.

Croton sparsiflorus reaches United Provinces.

Croton sparsiflorus Morung is a Euphorbiaceous plant which has comparatively very recently been introduced into India and the date of introduction of which into this country is known to a close degree of approximation. The early history of its establishment and spread in this country was given in 1908 by Bruhl[1]. According to him the species first arrived in Bengal somewhere near 1897 or 1898 by way of Chittagong and from there made its way up the Magna and across to the mouths of the Hughli. By the year in which Bruhl[1] published his paper, *i.e.*, by 1908, it had firmly established itself in the various suburbs of Calcutta, like Sibpur, Garden Reach, Shalimar Railway Yard, etc. Since then it has spread not only over the greater part of Bengal, but also as far east as Assam. In April 1932, I saw it growing very abundantly in the latter province at such places as Sylhet and Gauhatti. In 1921, the plant was recorded from Orissa by Haines.[2] He described it to be very common on the banks of the Mahanadi near Cuttack and Balasore. And now, since December 1931, I have been seeing the plant growing at Benares on the banks of the Ganges, especially near the place where the small river Barna joins the former.

From the records given above, it is clear that the species is spreading quite rapidly and it is very probable that in a short time the species may be able to cover the greater part of the country. It is now growing, according to the writer's own observations, in Bengal and Assam and probably also in Orissa as abundantly as does the prickly Mexican poppy, *Argemone mexicana* Linn, all over the country and it is not impossible, if the climate of all provinces is found suitable, that *Croton sparsiflorus* may attain the same amount of distribution and population in this country as the former plant. That it will sooner or later become very common in the Presidency of Madras, may be predicted with a fair amount of certainty.

From the published records of *Croton sparsiflorus* in this country and from the writer's own observations, it is seen that the species is everywhere more commonly found on the banks of the rivers and streams. This is especially clear at places

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[1] Bruhl. *Jour. & Proc. Asia. Soc. Bengal*, New Ser., **4**, 603-656, 1908.

[2] Haines, *Botany of Bihar and Orissa*, Part II, 1921.

where the plants have reached only very recently. When Bruhl wrote his paper, the species was found at Calcutta mostly near about the Hughli. Now it is abundant on everyside there. At Sylhet, I found it to be growing most abundantly on the banks of the Soormah. Haines found it in Orissa to be most abundant on the banks of the Mahanadi. At Benares, I have collected most of the specimens of this species from the banks of the Ganges and the small stream Barna. So far, I have been able to get only one specimen from some distance from the Ganges. This shows that the species most probably has been spreading along the banks of the various streams.

A. C. JOSHI.

Department of Botany,
Benares Hindu University,
February 7, 1934.

Influence of Magnetic Field on Electrolysis.*

WE have observed that the current passing through two platinum electrodes placed symmetrically in a solution of an electrolyte changes in value if a magnetic field is applied at right angles to the current. With different electrolytes the change in the electrolysing current is either an increase or a decrease and remains more or less steady for the short time for which the field is kept on. On cutting off the field the current tends to attain its original value.

The changes in the electrolysing current were measured by a milliammeter placed in series with an electrolytic cell which was well cleaned before each observation. The electrodes employed were rectangular and were fixed to a glass vessel parallel to each other. They were made of stout platinum foil and there was no chance of movement. The following is the list of the electrolytes which showed the above described magnetic effect.

TABLE I.

(*a*) Increase in the electrolysing current.	Copper and zinc sulphates; copper and silver nitrate; copper, zinc, stannous and mercuric chlorides; copper acetate.
(*b*) Decrease in the electrolysing current.	Barium, strontium and cobalt nitrates; nickel, aluminium and manganese chlorides; potassium dichromate, chlorine and bromine water and iodine in potassium iodide solution.

The amount of the change in the electrolysing current is very small in concentrated solutions but it increases rapidly as the solutions are diluted. In dilute solutions (*a*) type of electrolytes show a greater change than the (*b*) type. On increasing the strengths of the electrolysing current and of the magnetic field the magnitude of the change increases almost linearly. The electrolysing current varied from 60–150 milliamps. and the magnetic field was 3,700 gauss when the distance between the pole pieces was 20 mm.

By carrying out experiments with rectangular electrodes capable of rotation through any desired angle, it was observed that the maximum effect was produced when the electrodes were parallel.

It was further noticed that the bubbles of gases which are liberated during the electrolysis of a solution and which rise upwards along the surfaces of the electrodes, move in a spiral path round the electrodes as soon as the magnetic field is switched on. On careful examination it was noticed that the big bubbles of gases are deflected sideways from the electrodes during their upward journey while the tiny ones are deflected according to the direction of the magnetic field.

MATA PRASAD.
N. B. CHOKSEY.

Chemical Laboratories,
Royal Institute of Science,
Bombay,
February 19, 1934.

* One of the authors (M. P.) gratefully acknowledges a research grant from the University of Bombay.

Syphacia sciuri n.sp., A New Oxyurid-Worm from *Sciuris palmarum*.

ONE male and four female specimens of a new Oxyurid-worm were recovered from the large intestine of a squirrel *Sciuris palmarum*.

The females measure from 2·46 to 3·24 mm. in length and 0·19 to 0·23 mm. in breadth. The vulva is situated anteriorly at a distance of 0·61 mm. from the cephalic end (Fig. 1). The eggs are oval and measure 0·11 × 0·04 mm.

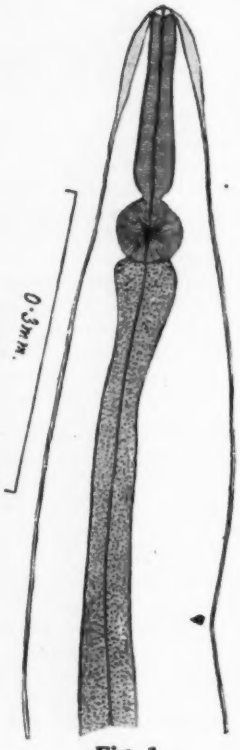

Fig. 1.

S. sciuri n. sp. Anterior extremity of Female, showing the vulva.

The solitary male measures 1·3 by 0·8 mm. The caudal end is pointed and curved ventrad. Above the cloaca there are three distinct "mamelons". Two of these are situated on the ventral side and one on the *dorsal side*. There are two pairs of preanal and one pair of post-anal pedunculated papillæ. The spicule measures 0·07 mm. in length. The gubernaculum is directed transversely. Small caudal alæ are also to be noticed. There are two lateral alæ present in the region of the intestine, spreading from beneath the bulb of the œsophagus to just above the cloacal aperture (Fig. 2).

The mouth is bounded by three lips and a buccal capsule is absent. The œsophagus is 0·24 mm. long including the bulb. It consists of an anterior club-shaped portion and a posterior spherical bulb with a valvular apparatus and separated from the rest by a constriction. A pair of small lateral cervical alæ is present.

This species closely resembles *S. obvelata* but it distinctly differs from it in possessing a cuticular "mamelon" on the *dorsal side*. This character is enough to create a new species and in this connection we suggest that the presence or absence of a dorsal "mamelon" be added to the generic characters of the genus *Syphacia seurat*, 1916.

We take this opportunity to express our sincere thanks to Dr. Baini Parshad for lending us, from time to time, the desired literature from the Library of the Zoological Survey of India, Calcutta.

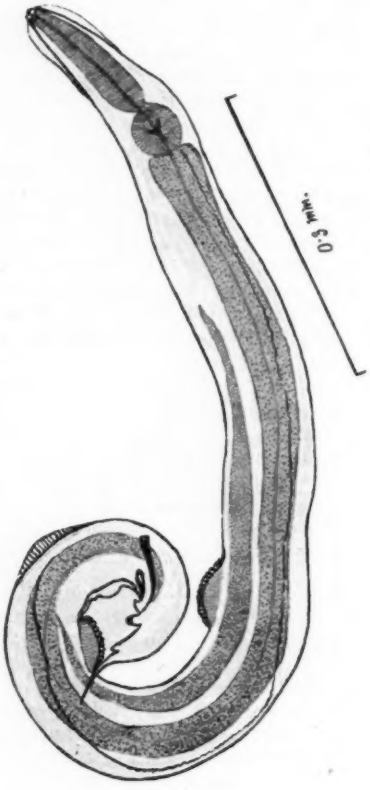

Fig. 2.

S. sciuri n. sp. Entire male.

Type specimens are in the Museum of the Zoological Laboratories, Muslim University, Aligarh, U. P., No. 1,000.

M. B. MIRZA.
SATYA NARAIN SINGH.

Muslim University,
Aligarh,
February 20, 1934.

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Railliet and Henry, A., *C. R. Soc. Biol.*, **79**, 113, 1916.

Seurat, L. G., *C. R. Soc. Biol.*, **79**, 64, 1916.

Riley, W. A., *Jl. Parasitology*, **6**, 89, 1920.

Yorke and Maplestone, *The Nematode Parasites of Vertebrates*, London, 1926.

Fluorescence excited by Circularly Polarised Light of λ 3131 Å.

A LOT of experimental work has been done on the polarisation of fluorescence of the dyestuffs in glycerine solution when excited by plane polarised monochromatic radiations of different wavelengths. In all the investigations it was observed that the polarisation of the fluorescence when excited by λ 3131 is *negative*,[1]—a fact which is rather very perplexing. Now it is perhaps of interest to enquire whether the fluorescent light emitted by the dyestuffs in a viscous solution under the influence of circularly polarised light of λ 3131 is polarised or not in view of the aforesaid negative result.

It may be mentioned here in passing that the fluorescent radiations being incoherent[2] we should expect them to be unpolarised in the forward direction when excited by circularly polarised radiation of whatever wavelength.

The experimental arrangement is as follows:—The light of λ 3131 of mercury arc issuing out of a monochromator, after being circularly polarised in the usual way with the help of a nicol and a quater wave plate, was incident on a rectangular cell containing fluorescein in glycerine. The resulting fluorescence was observed in the forward direction through another suitably oriented quater wave plate and a nicol. The intensity was found to be independent of the orientation of the nicol showing the unpolarised nature of the fluorescence.

S. M. MITRA.

Physics Laboratory,
Dacca University,
February 23, 1934.

[1] *Nature*, **131**, 204, 1933.
[2] *Cur. Sci.*, **2**, 127, 1933.

On the Dissociation of CO_2.

RECENTLY we published a note on the dissociation of PbO_2 and its connection with the band spectrum of PbO.[1] The calculation was based on the assumption that, since there is no difference between the O atoms either chemically or spectroscopically, the linkage will be due to four equivalent p electrons of Pb. So the products of an adiabatic dissociation of the PbO_2 molecule will be two unexcited O atoms and a Pb atom which is neither in its ground state ($s^2p^2\ ^3P$) nor as sometimes assumed in the state ($sp^3\ ^5S$) but in the anomalous term ($p^4\ ^3P$). We mentioned already that we supposed the CO_2 molecule to be linked in the same way but did not publish the calculation for CO_2 since at that time we had no possibility of testing the figures. Meanwhile Adel and Dennisson[2] have calculated the constants of the CO_2 molecule using the data of the infra red spectrum. It follows from their calculation that the total energy of an adiabatic dissociation of CO_2 in its three constituent atoms amounts to 33·33 volts, a value in surprisingly good agreement with the sum of the thermochemical dissociation energy of CO_2 into CO+O (5·48 volts) *plus* dissociation energy of CO into normal atoms (10·45 volts) *plus* excitation of the C atom to the anomalous $2p^4\ ^3P$ state (17·42 volts).

To our mind this agreement is a conclusive proof of our assumption as to the linkage of tetravalent carbon. A full report will be given elsewhere.

H. LESSHEIM.
R. SAMUEL.

Muslim University,
Aligarh,
February 1934.

[1] *Cur. Sci.*, **1**, 374, 1933.
[2] *Phys. Rev.*, **44**, 99, 1933.

Research Notes.

Nutrition and Cattle Breeding.

IN a very interesting and useful article (*Agriculture and Livestock in India*, **3**, 549, 1933) K. C. Sen has dealt with some of the nutritional factors affecting breeding operations of cattle which will prove to be of real practical value to the agriculturists and the animal husbandmen alike. Our knowledge about the dietary requirement of Indian cattle as regards their growth, reproduction and general well-being is very poor. The improvement of the breed, the fertility of the animals, the milk production and resistance to diseases can be regulated to a great extent by a careful and judicious selection of the diet. The result of an experiment carried out at Muktesar shows that by adding 4 oz. of bone flour per day from the dry period after the second lactation, and providing a well-manured grazing land for the cow, the milk production in the third lactation increased from 2,438 lbs. to 4,061 lbs. and in the fourth lactation during 293 days the yield of milk was 10,000 lbs. This is a remarkable success in increasing milk yield. The quality of milk produced is also directly related to the ration supplied. In order that the milk may be rich in all the accessory food factors essential for proper growth of calves, it is of utmost importance to see that proper nutrition is provided to the dam. Minerals also form an important constituent of milk; their deficiency in the ration may be a limiting factor in milk production. Beside the milk yield, a high birth-rate in the herd and the bearing of normal and healthy calves are very important from a farmer's point of view. Unfortunately, however, abortion in females of non-specific origin is very common in India. It has been demonstrated by American workers that deficiency of lime in the diet produces abortion or lends to the birth of weak calves. Lime deficiency occurs where grazing is not provided and is very common amongst stall-fed animals. One of the commonest symptoms of this deficiency in animals is their attempt to eat earth and mud in their pens.

It has been observed by workers in America and South Africa that phosphorus starvation in cattles leads to diminished fertility and a decrease in milk yield. In one experiment, the addition of bone meal to the ration raised the milk yield by 40 per cent. and increased the average number of calves born in a herd by 30 per cent. This fact is particularly important for India since natural pastures in this country are highly deficient in phosphorus. Diseases like anæmia, goitre, rickets, osteoprosis, emaciation and loss of condition, etc., are associated with faulty mineral metabolism and require immediate attention. Minerals like fluorine and iodine also appear to effect breeding operations. An excess of flourine in the diet may cause sterility while deficiency of iodine leads to endemic goitre and breeding difficulties. It is only very recently that attempts have been made to correlate sterility with vitamin deficiency. Absence of vitamin E and vitamin A in the diet causes degeneration of germinal epithelium and hence leads to sterility. Under an intensive system of dairying with stall-fed animals and in places where green pastures are not available, there is a real danger of a deficiency of vitamin A and D. The birth of blind calves, teratomatous growth on eye balls, twisted nose and other bony deformities which are very common in many parts of India are probably connected with vitamin deficiencies in the diet. A hypo or hyperfunction of some of the endocrine organs such as thyroid and pituitary, may cause sterility as a result of unbalanced ration supply to the animals.

The result of the experiments carried out in the Punjab and Pusa have shown that it is possible to improve the local breeds available in India by selective breeding and judicious feeding, provided the degeneration has not proceeded too far.

Improvement in the cattle-breeding involves therefore a number of considerations, and a knowledge of nutritional requirements of the animals will prove to be of great value to the former. Considerable research in this direction will be necessary to overcome the numerous disorders of nutritional origin and to correlate the susceptibility of animals to various types of parasitic infections and diseases in general, with nutritional deficiency.

N. C. DATTA.

Wood Preservatives: Their Selection and Testing.

TIMBER is one of the commodities that find a large application in every-day life for several purposes and under diverse conditions.

It is common experience that this material even when it is properly seasoned, is easily attacked by fungi and termites, unless treated with toxic chemicals. Therefore a satisfactory method of testing the various wood preservatives for their potency against such attack is a welcome addition and forms the theme of a contribution by S. Kamesam (*Forest Bulletin*, Economy Series, Bull. No. 81, 1933). The different preservatives, including the patented "Falkamesam" one, have been studied at great length. The successful employment of a preservative in practice is conditioned by its ready availability, low cost, its high toxic coefficient against the destructive agents in low concentrations, its permanent retention in the treated pieces and a few others, which have been adequately discussed in Part I of this publication.

A large part of the paper (Part II), deals with the technique of determining the toxic action of the preservatives on the wood-destroying fungi and insects. This technique which is in vogue in European countries, has been evolved by Dr. Falck with whom the author had collaborated in evolving a new preservative. The various solutions were tried on three wood-destroying fungi *viz.*, *Coniophera cerebella*, *Lenzites thermophilla*, and *Fomes annosus*, after being impregnated in wood pieces and air dried. The arsenicals stand supreme in their destructive action, which property has been largely utilised in the latest process. In fact, Dr. Falck long ago had established the high fungicidal coefficient of arsenic, in very low concentrations. Experiments conducted with beetles particularly *Calandra* and *Dinoderus* sp. led to the same findings. In both cases, the superiority of the recently patented preparation is emphasised. Besides this, Thanalith U, Sodium fluoride, and Copper sulphate possess a destructive action on these in certain useful concentrations. Coal tar creosote, on the other hand, is not very effective.

Leachability tests show that arsenic can be fixed in wood, under conditions developed by the author. This fixation is influenced by the presence of dichromate. It is therefore interesting to investigate the mechanism of fixation of this poison in the wood and it is equally important to assess the rôle of chromium in the process. Even arsenic in the arsenious state and other non-arsenicals have proved a failure as preservatives. In the "Falkamesam" and other arsenical preparations, no evidence of attack on mild steel has been noticed.

In Part III the author presents tentatively an ingenious method of determining the value of a preservative with the help of the several tests mentioned before. To this end, "weightage numbers" are indicated under each test, depending upon the toxicity of the chemical employed. The sum total of these numbers represent "composite value indices" which should give a clue to the potency of the solution. Thus "Falkamesam" and colloidal arsenic trisulphide mixed with sugar (Indpal Patent) have an index of 35, while arsenic trioxide has only 28 as the index. Copper sulphate and zinc chloride, on the other hand, score hardly 16.

The final part is devoted to a critical examination of the preservatives in relation to the method of utilisation of timber. Thus when wood is employed in outside location, the highly toxic chemical must be fixed permanently, a condition satisfied remarkably by the "Falkamesam" fixative. Again, timber permanently located in water does not require any treatment. In other cases, the treatment is varied according to the use to which the wood is put, for which the original paper should be consulted.

In the end, it is necessary to point out that several interesting points have been raised requiring detailed study. The simultaneous fixing of copper and arsenic in wood announced by the author, would appear to be the best treatment so far evolved for preserving timber. A publication on the same is keenly awaited.

V. I.

The Featherback Fish *Notopterus chitala* (Ham. Buch.)

IN the August issue of *Current Science* (**2**, 71, 1933) attention was directed to the valuable contributions of Dr. H. M. Smith to the ichthyology of Siam. Two further articles have now appeared in the same series (*Journ. Siam Soc. Nat. Hist. Suppl.* **9**, pp. 245-260, pls. viii–ix, 1933), and of these the one dealing with "The Featherback Fish *Notopterus chitala* in Siam, with Notes on its Egg-laying and Young" is of special interest to students of Indian fishes, as the species is widely distributed in India and is of considerable economic importance.

In Siam, the egg-laying period of *N. chitala* extends from January to August, and the

eggs are attached in a single layer to piling posts, stakes, or stumps. It has been ascertained that each fully mature female lays three separate batches of eggs in the course of a single season. The eggs are comparatively numerous, and the care of them devolves on the male parent. At an average water temperature of 33°C. the incubation period is 5 to 6 days. Immediately after hatching, the young drop to the bottom and occupy a small shallow depression prepared by the parent fish before the eggs are laid. The article is full of valuable information from the point of view of pisciculture and the fisheries officers in India will find the paper of exceptional interest. Dr. Smith has to be congratulated on having produced a paper of such great merit.

Cytological Studies on Plant Tumors and Triploid Hybrids.

THE notable progress made during recent years in experimental biology, specially on gene mutations and chromosome aberrations caused by X-rays, violent changes in temperature, mechanical injuries, etc., and on the production by hybridisation of fertile polyploid hybrids, has led to a belief in two parallel modes of descent, *viz.*, a mutative and a synthetic descent. Dontcho Kostoff has made considerable additions to our knowledge of these phenomena. Extensive morphological, histological and cytological studies have been made by him on the tumors and polyploidy produced in various plants by bacteria and chemicals (*Arch. f. Microbiology*, **4**, 1933). The tumors caused by injecting *Bacterium tumefacium* were found to be similar to those caused by various chemicals and to the spontaneous tumors on hybrids. In *Genetica*, **15**, 1933, he has described numerous abnormalities in chromosome behaviour and the sterility caused in *Nicotiana* by virus diseases. Biophysical studies have shown an increase of cytoplasmic viscosity in these tumors and the origin of polyploids is due primarily to the resistance offered by the highly viscous cytoplasm to the normal movement of chromosomes to the poles and to the formation of a nucleus before such movement is completed. Retardation of meiotic processes may also be the result of abnormal biophysical and biochemical processes created by hybridization as shown by him in pollen abortion in hybrids of *Secale* (*Cytologia*, **3**, No. 4, 1932). In the production of stable new hybrids Kostoff has been successful in breeding a triple fertile hybrid of *Nicotiana* (*Bull. Appl. Bot. Gen. and Plant Breeding*, Leningrad, **2**, No. 2, 1933). Comprehensive morphological, cytological and genetical studies of this form, a triple hybrid ($n=24$) of *N. tabacum* ($n=24$), *N. sylvestris* ($n=12$) and *N. Rusbyi* ($n=12$), show that it combines the character of all these species, and is cytologically balanced and produces normal gametes. He has again described in *Cytologia*, **3**, No. 2, 1932 a similar triple hybrid of *Triticum* ($n=42$) possessing the characters of all the three species [(*T. dicoccum* ($n=14$) × *T. monococcum* ($n=7$) × *T. vulgare* ($n=21$)].

Courtship of Lizards.

IN *Natural History*, **34**, No. 1, 1934, G. K. Noble describes a series of experiments conducted on the field by him on the American fence lizard, *Sceloporus undulatus*. The males of this species possess on their under-sides a bright blue stripe the significance of which was obscure till now. The male generally rules over a small area and makes it almost his own and exhibits great intolerance towards any male trespassers. Whenever he sights intruders, he compresses and raises his body in such a way as to show off his brilliant lower surface, which serves as a warning to the intruders to quit. Such colourful exhibitions are not manifested when he sights a female within his territory. The males are able to identify the sex of another individual even at some distance. But the recognition of sex seems to be chiefly by means of colour and in experiments where the blue stripe of the male was hidden by paint or by tying the legs of the animal in such a way as to obscure it the males were unable to distinguish the sex and mistook the intruders to be females and sometimes even began to court them. The movements of the two sexes are different and sometimes offer an additional clue to their recognition. The females are indifferent as to their habitat and reconcile themselves with any new area to which they may be introduced but the males generally find their way back to their own homes provided the distance is not too great.

The Kaolin Minerals.

IN a recent paper *U.S. Geol. Surv. Profess.*, Paper No. 156–E) C. S. Ross and P. F. Kerr have given a brief account of their recent investigations of the clay minerals, in the

laboratories of the United States Geological Survey. The authors have effectively supplemented the older methods of investigation by the more recent one of studying crystalline powders by X-ray diffraction patterns. They have thus been able to show that instead of one kaolin mineral, as has been commonly assumed, there are at least three which are stable at different temperatures and therefore formed probably under dissimilar conditions. Kaolinite, the most abundant of the three, is the source of most, if not all, of the kaolin and 'china clay' of commerce.

Nepheline Syenite from Rhodesia.

In a recent number of the *American Journal of Science* (**27**, No. 158, Feb. 1934) Frank D. Adams and F. Fitz Osborne have described an interesting type of nepheline syenite from Northern Rhodesia. In hand specimens, these rocks have medium granularity, and often show pitted surfaces due to the removal of felspathoids by weathering. The felspars stand out and show more or less idiomorphic outline. A pale green fibrous pyroxene is common. Muscovite is found in some specimens. Of the felspathoids some varieties show only a gray nepheline; others show a pale blue nepheline associated with a more deeply coloured sodalite and a honey yellow cancrinite. The red aggregate known as *Spreustein* or hydro-nepheline replaces part of the nepheline and sodalite of some of the rocks. Under the microscope, the felspars are seen to be of two kinds, microcline and albite; and most of the albite appears to have replaced microcline. The muscovite, in part, appears to have replaced felspathoids, between grains of albite. Magnetite, zircon, and perovskite are the common accessories. The authors consider these rocks as affording a particularly interesting example of the formation of minerals of unusual composition due to the abnormal composition of the magma.

The State of Water in Gels.

By Dr. K. Krishnamurthi, D.sc. (London), *College of Science, Nagpur.*

THE capacity of certain colloidal solutions and gels to hold a quantity of the intermicellary liquid with great forces of attraction has been long recognised. The effect that such a binding has on the state of water has been the subject of a number of investigations. Several workers tried to find out the behaviour of this "bound water" when the colloidal solution or gel was frozen. Mölich (*Sitzungsber. Akad. Wiss. Wien.*, **105**, 1896) appears to have observed that, when a 2% gelatin gel was frozen, the gelatin formed a net-work, the spaces in which were filled with ice masses and air-bubbles. Liesagang's investigations showed (*Koll. Zeit.*, **98**, p. 523, 1906) that water was not separated from gelatin during freezing and subsequent thawing. Hardy's microscopic examination (*Proc. Roy. Soc.*, **112 A**, pp. 47-61, 1926) revealed the fact that ice crystals were formed in the gelatin gel while freezing and that, during the subsequent thawing, the water was re-absorbed in the surrounding gel leaving only a tiny cleft.

Quantitative methods for the determination of the percentage of bound water in the gel were chiefly based on the examination of some physical properties of water which underwent marked changes when present in the "bound" condition. In one class of methods the gel was first frozen, when a certain proportion of the water—presumably the "bound water"—remained in the unfrozen condition, and the amount of the frozen water, which corresponded to the unbound or "free" water, was determined firstly from the changes in volume produced on freezing the gel or during the subsequent thawing, or secondly from the quantity of heat required to melt the ice. Another method suggested by Newton and Gortner (*Bot. Gaz.*, **74**, pp. 442-446, 1922) involves the determination of the amount of water available to dissolve a soluble material, and from this the amount of water, which cannot act as solvent, and which therefore corresponds to "bound" water, can be easily calculated.

It may be useful at this stage to consider how far the above-mentioned methods give us an accurate estimate of the amount of "bound water". In the first place, these methods are based on the assumption that the water, which is held with great forces of attraction by the gel-micells, is incapable of

being frozen and of acting as a solvent. Both or at least the second of these assumptions may be only partly correct. Further, in the volume-change method referred to above it was assumed that it was possible to calculate the quantity of water frozen, that is, the "free water", by measuring the expansion produced by the formation of ice during the freezing of the gel. Here apparently, the decrease in volume brought about by increased binding of the water at lower temperatures was not taken into consideration.

In spite of all the investigations referred to above the exact nature of this "binding" process has not yet been clearly stated by other workers. In 1928 the writer of this article suggested (Krishnamurti, D.Sc. thesis, London University, 1929, p. 182) that some of the molecules of the intermicellary water are oriented under the influence of the residual valency forces possessed by the molecules of the dispersed substance, and that only in certain parts of the colloidal micell are these forces strong enough to exert an appreciable action on the molecules of the water. Strong evidence in favour of this view was obtained by examining in an ultramicroscopic field a gelatin sol during the process of setting, when it was observed that a few small particles were drawn with greater force to certain portions of the surface of the gel-micells than to others.

In continuation of the previous researches I have been carrying out investigations to gain further information regarding the actual state of "bound water". Mr. C. Subramaniam and I examined more than one year ago, with the help of a specially constructed apparatus resembling a dilatometer, the differences between the volumes of agar sols and gels of the same concentration at the same temperature, and we did notice a measurable, though small, contraction during gel-formation. Svedberg (*J. Amer. Chem. Soc.*, **46**, p. 2673, 1924) measured the volume contraction produced during the imbibition of water by dry gelatin. But the observation described above has not been reported, so far as I am aware, by any other worker. The volume contraction resulting from gel-formation was found to be 0.021 c.c. at 75°C. in our experiments, and slowly increased to 0·029 c.c. by lowering the temperature to 55°C.

This decrease in volume during gelation is clearly a result of increased binding of the intermicellary water by the colloidal micells when the sol is converted into a gel. It is further clear that this binding of water is not a process which converts it into ice, but that the "bound water" is under the influence of strong forces of attraction, which bring about an orientation of the molecules of the "bound water" and a contraction in its volume.

Previous investigations on the light-scattering in agar sols and gels (K. Krishnamurti, *Proc. Roy. Soc.*, **122 A**, p. 76, 1929) have clearly shown that the light-scattering capacity of the gel is distinctly much greater than that of the sol, and that this difference increases as the temperature is lowered. There is thus a parallelism between this and the variation of the volume contraction with temperature. Parallel measurements of the sedimentation velocity in the ultracentrifuge and of light-scattering in gelatin sols have revealed the fact that an increase in light-scattering indicates an increase in the particle size. It is therefore clear from the results mentioned above that during the transformation of agar sols into gels there is an increase in particle size brought about by the aggregation of the primary colloidal particles or the "large molecules" of agar, and that with lowering of temperature there is an increase in the aggregation of the particles as well as in the amount of "bound water". This probably explains why there is usually a parallelism between the strength of the gels formed and the extent of aggregation of the original particles.

Similar investigations using various gels under different conditions of temperature, pH value, and so on, are in progress, and are expected to throw more light on the nature and intensity of these forces, which are responsible for the "binding" of water by the gel-micells.

150th Anniversary Celebration of the Asiatic Society of Bengal.[1]

ALL ancient institutions worthy of the name have their established traditions and customs, and there is, I understand, in our venerable Society a practice—comparable perhaps to the Hindu custom of abstaining from all forms of study on the day sacred to the Goddess of Learning—of removing, once in twenty-five years, most of the outward and visible signs of scholarship from this historic hall to make place for a banquet in celebration of the passing of another long stage in our career. "Dulce est desipere in loco." Some of us have perhaps forgotten our Horace but if by the succinct phrase "in loco" the poet meant a qualification not only of place but of time,—and this is borne out by the well-known rendering "a little folly now and then is relished by the wisest men"—then time and place are peculiarly suitable for our laying aside the aspect of the scholar this evening for the place is the Society's own home, built for them, on a site provided by the old East India Company's Government, 126 years ago and inhabited by the Society continuously ever since; and the occasion marks the passage of a century and a half since a small company of scholars met together at the invitation of Sir Robert Chambers to found our Society and to inaugurate those meetings which in their early days assembled under the presidency of Sir William Jones in the Grand Jury Room of the Court at Fort William.

Properly regarded, such an occasion should be both symbolic in nature and ceremonial in form—the essence of the ceremonial being the creation of that common atmosphere of feeling and understanding in which an ideal may be more clearly visualised and an aspiration more deeply felt. To put it another way: a ceremonial meeting is not the appropriate place for giving or receiving detailed instruction but should have for its aim the cultivation of a mood.

For these reasons, Gentlemen, I do not propose to indulge in any reflections on the individual features, important though they be, of the Society's long career as outlined in the most interesting address of the President. I would rather notice broadly some of the salient features of to-day's celebrations—"broadly" because while the eye is the instrument best suited to the leisured assimilation of detail, the organ to which I must appeal to-night, the ear is more apt for the perception of general principles.

In the first place, then let me recall the stress that Indian philosophy has laid on the evanescence of all things in this material world. Empires decline, dynasties fall, great men and small pass on, and institutions once firmly established come to an end. Notwithstanding changing times—and has any other period of equal length been so fruitful of changes as the period 1784-1934?—the Society has managed to survive in vigour a century and a half of arduous labour. I am not sure that we fully realise how little of institutional life has come down to us from the days before the French Revolution. That there are still extant Academic Societies, Museums and Universities ante-dating that event cannot be gainsaid, but their number is comparatively limited. Here in India not many institutions remain unaltered from those remote days. The very Indian Empire in its present form has only half the Society's span of years. Survival is dependent on vitality; and in all human institutions the test of vitality is activity. It is therefore a proof of the past activity of the Society that it has been able to survive till to-day. For the last ninety years our membership has mostly oscillated between three and five hundred; and though it went beyond this maximum during a brief period between 1925 and 1932, it is within the same limits that we find ourselves now. Periodical fluctuations in membership have not, however, interfered with the general rate of progress since the foundation of the institution. We are justified in concluding therefore that the Society has well maintained its health and vitality despite advancing years.

And what of the Society's activities during the third half century of its existence? Have we anything to show comparable to that series of giants who were associated with the Society's work in the beginning, in the days of Sir William Jones and his immediate successors whose records are to be found in the pages of our Centenary Volume? The President has brought forward an imposing array of names of scholars outstanding in the fields of the Natural Sciences and of Philology and it would not be difficult I believe to add to his list. It is gratifying and may even come as a surprise to some—to note that the Society is able to cite from amongst the members active within its ranks during the last fifty years more than a score of men who have won for themselves a place in the world's encyclopædia of scholarship—men who have helped materially to mould modern views in science and in letters. That this is not an empty boast is strikingly and abundantly proved by the addresses that have come to us from centres of learning all over the world. I venture to think that it may be something of a revelation to many members of the Society to "wake up" as it were "and find themselves" in the person of their Society "famous"—to hear the warm praise bestowed upon its work by learned bodies in distant countries, the praise of the Zoological Society of London for the Society's work in Zoology, of the Linnean Society for its work in Botany, of the Prussian Academy for its indological researches and of representative institutions of four continents for its labours in the Geological, Anthropological, Archæological and other fields. Can it be that the old saying "a prophet is not without honour but in his own country" is of application to the Asiatic Society of Bengal?

Another aspect of this celebration is the gratifying demonstration that it affords of the intellectual solidarity of the world. I understand that no addresses or congratulations were invited by the Society and that all the messages and tributes received have been spontaneous. Some thirty institutions, representing fifteen countries, have expressed their good wishes in messages which constitute a rare testimony to the esteem

[1] Speech by His Excellency the Right Hon'ble Sir John Anderson, P.C., G.C.B., G.C.I.E., Governor of Bengal and Patron of the Asiatic Society of Bengal.

in which the Society is held in the world of scholarship to-day. We are particularly happy to welcome here to-day Monsieur Delacour of the National Museum, Paris, and Mr. Alfred Ezra, representing the Zoological Society, of London of which he is Vice-President. It is also gratifying to see the number of Societies from India and Ceylon participating in our celebration. A dozen of them are represented either by personal attendance or by addresses. The Ceylon and Assam Societies have deputed their Presidents to be with us, and Bombay and other Indian centres of study are also well represented here to-night.

From all this it is very evident that the Society has both a national and an international significance and the citizens of Calcutta would do well to consider in what way they could take a greater share in the support and the renown of the institution established so long in their midst. According to the traditional formula as one who is anxious to promote the progress of science and literature is eligible for membership technical or academical qualifications are not indispensable. We must of course have our scholars, our specialists and our workers, but we are equally in need of patrons and supporters. In this connection I have noted with satisfaction the traditional connection of the order of Ruling Princes with the Society. A considerable number of the Ruling Princes of India have always been members. It would be a happy thing if this tradition could be widened and made permanent and if a day might come when the name of no substantial Ruler in this country would be missing from our members' list to the great benefit of scholarship in this vast country. If it is too much to hope that the Society's Members' list should be a complete directory of the aristocracy of the country, social and intellectual, it is at least reasonable to expect that a society of the standing which this Society enjoys, and one pursuing as its object the study of all that is produced by Nature or made by man within the limits of Asia, should draw its main support from sources not confined to the Municipal limits of Calcutta.

I had not intended this evening to make any personal reference within the Society but looking round me I feel I must make one exception. A past president of the Society and still an honorary fellow, Sir Rajendranath Mookerjee has been for many decades a personality and a leader in almost every intellectual and progressive movement in this city. Advancing years make participation in functions like this an increasing burden to him but I wish to say that we regret his absence and we think of him with affection.

We have to-night elected in honour of the occasion twelve Anniversary Fellows of the Society. Drawn as they are from countries and from a great variety of fields of study, they illustrate once more the catholicity of our interests. Their names are a sufficient commendation and I will only say that I congratulate them and the Society on the honour which their election confers on both.

Ladies and gentlemen, it would, I am sure, be your wish that I should in my own name and yours express, however briefly, our thanks to those responsible for the organisation of these anniversary celebrations. An occasion of this kind entails a vast amount of forethought and labour and we owe a great debt of gratitude to the Anniversary Celebration Committee of which Dr. Hora is the energetic Secretary and to our own General Secretary, Mr. Van Manen, for the arrangements which have made possible so pleasant and inspiring a celebration.

It now only remains for me to congratulate the Society on a brilliant past and to wish it an equally brilliant future. The secret of real success in a Society of this kind is disinterested effort. In the realm of mind we are all brothers. May your labours for the future be marked by the same unselfish zeal and enthusiasm that have distinguished them in the past! Only by these qualities will enduring results be obtained. I trust that it may be vouchsafed to the Society to inaugurate to-day a new period of its life—a period worthy of its distinguished past and of the promise that the present holds—so that when once more, after another half century has gone, our successors assemble to review the period then closing, they may still be able to say with truth, as we are happily in a position to say to-day, that a worthy tradition has been worthily followed.

A River Physics Laboratory for India.[1]

THERE are many lines in which the Government of India as well as the provincial governments can profit immensely if they take the trouble of obtaining proper scientific guidance before launching on large-scale enterprises. As many such cases are not known to all, I would refer to only one. Year after year the Government and other public bodies spend an enormous amount in constructing bridges and water reservoirs, in opening canals, in development schemes, in hydro-electric schemes and in city drainage schemes. These schemes are certainly highly beneficial and undertaken with the best of intentions, but from time to time, very unpleasant facts leak through the columns of the news agency, which show that these schemes are mishandled at some stage or other. Every scientific man knows that before the actual working commences the plans should be scientifically studied in Hydraulic Research Laboratories, with the aid of models and the engineers in charge of constructions should have a clear-cut idea of the work before they are put in charge of it. In spite of the fact that next to the United States of America, India is the country which has undertaken such works on the most gigantic scale, and has spent hundreds of crores of rupees on these works, the Government has not yet thought fit to establish a single Hydraulic Research or River Physics Laboratory in this country while in other civilised countries no such enterprise is allowed to be undertaken unless the plans are examined in suitable laboratories attached to the Universities, Technical High Schools, or State departments with the aid of

[1] From the Presidential Address to the Indian Science Congress (Bombay), 1934, by Professor Meghnad Saha, D.Sc., F.R.S.

suitable models. To convey the idea of how such work is carried out in India, I have quoted the opinion of the late Sir F. Spring, an eminent engineer, who constructed a large number of railway bridges in India during the last generation and I would request my readers to read this very carefully. I should merely add that I am not against the launching of the schemes; in fact many of them, like the Punjab Canals, have done immense good to the country. But others like the Orissa and Midnapur Canals were constructed on faulty lines, and involved the State in huge financial losses; while other schemes like the laying of railway lines through major parts of Bengal without a proper examination of topography and of the river systems have plunged the country into perpetual outbreaks of malarial epidemics, and led to the sapping of the vitality of the population. I do not hold that either the engineers or the officials are responsible for these failures and disasters. In fact, I think that most of them like Sir F. Spring tried to make the best use of a bad situation. But the fault is due to lack of imagination on the part of those who have taken upon themselves the task of Government and to their failure in devising a proper system of co-ordinated work in which preliminary scientific study in suitable laboratories should form an essential part of the organisation.

The Absence of any Organisation for Recording Experience or Research in connection with the Physics of Great Rivers.—[2]

"As trustees of so fine a property as this—canals and railways—it might not unreasonably be expected that the State would see the importance of devoting a comparatively small annual appropriation to original research, on lines likely to be productive of a good return for the expenditure, in the form either of reduction in the first cost of its public works or of their safety and their economical upkeep when built. Heretofore there has been no pretence of organising any such research in connection with the engineering of the canals and railways of India. Engineers have gone on blundering, benefiting, rather by chance than by design, by the experience of their predecessors, and each considering himself lucky if he escapes disaster at the hands of the tremendous forces of nature—amongst which some of the most potent for good or evil are the great rivers—with which he has to struggle. Until quite recently there has been practically no encouragement, and indeed at times there has been discouragement, to men to publish their experiences. And so, in spite of having perhaps as fine a body of scientific engineers as any country, not excluding France, has in its employment, and in spite of this body of public servants having carried out daring and extensive works of a certain character, chiefly, in connection with the great Indian rivers, on a scale unparalleled elsewhere, the State possesses the most meagre record of the history of the works carried out so successfully by its employees. In putting the chapters of this book (*River Training and Control* by Sir F. Spring) together, the author found extreme difficulty in ascertaining what had been done, what difficulties had been encountered, and how these difficulties had been surmounted, and it has needed the expenditure of nearly a year of research to enable him to offer to the Government of India the advice, contained in the foregoing chapters, in regard to one limited phase of the engineering of great rivers. Time will show the value of that advice, and doubtless further experience will modify the practice recommended. But meanwhile the author urges on the Government the importance, from a mere money point of view, of insisting on the maintenance of an intelligent record of the history of such works as those dealt with in the foregoing chapters."

The Consequences of Lack of Organisation.

2. "With regard to the physics of long reaches of the great rivers, the author is not in so good a position to speak. His special experience has been gained rather on short lengths of such rivers in contiguity to his works. In view of his practical inability to regulate the flow of great lengths of such rivers he has viewed the inimical consequences of the irregularities of their flow, in the form of deep and dangerous scour, as requiring to be fought by sheer irresistible force rather than by coaxing. This necessarily must be the attitude of the engineer in charge of great bridges, and perhaps to a lesser extent of those in charge of great irrigation weirs. But they ought not, for that reason, nor ought the State, to lose sight of the importance of endeavouring, by consistent, logical and well-organised research, to learn something more definite than is now known about the physics of long reaches of rivers. A perusal of Chapters III and XXI, as well as of Mr. R. A. Molloy's Technical Section paper No. 118, will suffice to show how blindly, heretofore, in the interests of the residents on their banks, men have been fighting against the ill-will of some of the great rivers; whether on behalf of the maintenance of levees[3] whereby devastating floods are excluded from great inhabited areas; or for the conservation of the lands of inundation canals on whose integrity the welfare of many thousands of people is dependent; or in the interests of riparian cities whose obliteration would be a blot on the administration of civilised and intelligent rulers. It is difficult to avoid the conclusion, after perusal of Chapter XXI, that for lack of adequate knowledge, the engineers concerned with the interests of the inhabitants of the valley of the Indus have been obliged to work more or less in the dark in their fight with that river, and to make matters worse it has constantly happened that owing to the climate, to the exigencies of public service, no sooner does one engineer get some small inkling of the tricks than he is replaced by one with all his experience to gain; and in six months he, in turn, is replaced by somebody else whose experience of the river has perhaps been limited to crossing it. How under so haphazard a system, anything gets done at all is a marvel; and instead of being surprised at £ 100,000 worth of work having been wiped out, the State may congratulate itself if the loss is not double. However, there is always the satisfaction, in the case of such expenditure as that dealt with in Chapter XXI, that the whole of the money has remained in the country, and that if the tax-payer

[2] Opinion of Sir F. Spring on the need for a River Physics Laboratory quoted by Professor Meghnad Saha, D.Sc., F.R.S.

[3] This is a word of French origin, which is used in the U. S. A. to denote embankments.

takes money out of his coat pocket only to put it into his waistcoat pocket he can always pick it out again, or its equivalent."

Suggestion for the appointment of a River Commission.

3. "The appointment for say 10 years of a River Commission not merely for the Indus, but for the organised study of the physics of great alluvial rivers generally, would be a service to civilisation and an act worthy of a great State. The Mississippi Commission have done a great deal, but their experience is not to any great extent applicable to Indian conditions. The experience of the engineers of the Rhone and the Danube and other European rivers, though valuable in its way, is even less applicable to India than that gained on the Mississippi. Mr. R. A. Molloy's attempt at a theory, as summarised very inadequately in Chapter III, is the first that can be characterised as a scientific generalisation of the river problem that the author has heard of in India. And even this is based on inadequate data, picked up anyhow amidst the multifarious duties falling to the engineer to a system of inundation canals. There is need for a thoroughly scientific location, and for the automatic reading, of gauges at hundreds of places, for several years, along great lengths, selected with care and knowledge, of several of the great Indian rivers, also of some systematisation of the surveys which usually are undertaken on these rivers, and of the making of fresh surveys specially designed to elucidate facts also of an organised system of soundings and sections. The engineers in charge of the work must steadily keep in view the ultimate object of it, and must not make a survey merely for the sake of a section. The object in view will be: To present to the scientific world, and especially to the engineering world, and more particularly to the engineers of structures in India that are subject to fury at the hands of the great alluvial rivers, under various circumstances, as will allow of such action being anticipated; and especially to enable the engineer to utilise fully his knowledge of the rivers, so that he may make a servant of it, instead of being as it is now very often the case, his master. There can be no doubt at least from the author's point of view that more money has been wasted, for want of just such knowledge as a River Commission might provide, than would have sufficed to pay the entire cost of it many times over. Certainly, so far as training works in connection with bridges are concerned, in rivers of the class with which the author has chiefly concerned himself, most engineers responsible for such works would probably admit that whether they spent money unnecessarily as an insurance against their inevitable lack of scientific data, or that they were unduly economical with either disaster, or heavy annual recurring expenditure in after years, as the result. Thus looked on from the lowest or merely commercial standpoint, the establishment of such a Commission ought to be highly remunerative."

Milk and Bread.

THE Symposium organised by the food group of the Society of Chemical Industry in November last, an account of which has appeared in the *Journal of the Society of Chemical Industry* (Vol. **52**, pp. 363 T–414 T) is of very great public interest, as it takes stock of our knowledge concerning the two root components of the nation's dietary. Fourteen papers were presented at the meetings over which Prof. H. E. Armstrong presided.

NATION'S MILK SUPPLY.

In a communication of a more or less general character, Professor H. D. Kay has dealt with the all-important subject of the improvement of nation's milk supply and has given an informed review of the steps that have been taken and the steps that have to be taken to improve the milk supply. The problem has two aspects, the quality and the quantity; the former mainly concerns the consumer who wants for the money he pays an article of maximum dietetic value. The producer, on the other hand, is mainly interested in the quantitative aspect.

The factors that go to make the milk, the most important factor of our dietary, are the high content of animal protein of very high biological value, the easily digestible fat, the balanced salt content with valuable minerals for bone formation and the vitamins. The fact that, at an important stage of the life history of the animal, milk is the only article of diet makes it imperative for the mother to elaborate a food of such useful qualities.

The daily consumption of milk per person in Great Britain is only a third of what is desirable or necessary, and this grave situation calls for attention. The problem of increasing the production is not without difficulties but it has to be remembered that more liquid milk is produced in the country than is actually consumed as liquid milk. It would appear that consumers are not fully alive to the specific nutritional importance of milk, particularly for the growing child; the purchasing power of the poorer classes is low, although from a consideration of the nutritional value, milk is perhaps the best that can be purchased for the money. Added to these, not an inconsiderable part of the population fear that the supply from the bulked milk in large towns is not safe. The problem of increasing milk consumption is not one for the dairy farmer; the remedy lies in propaganda and education.

The quality aspect of the problem is not so simple. The ideal quality can be ensured if milk is produced under strictly hygienic conditions from normal healthy cows, and suffers no deterioration during distribution. This aspect involves agricultural, physiological, bacteriological, chemical and economic problems, and it is most important that the producer and the distributor apply the results obtained from scientific enquiries to actual practice.

CLEAN AND SAFE MILK.

The technique of clean milk production involves the application of hygienic principles to the cowshed and the dairy. In order that the milk may

also be safe for consumption, the cows should be, ideally speaking, entirely free from diseases communicable to man. This is, however, far from being true. Many milks, unfortunately, are infected with bovine tubercle bacilli, and it is a well-established fact that young children can become tubercular by consuming infected milk. The susceptibility to infection diminishes rapidly with advancing age. The bacteriological control of the milk supply is thus a matter of supreme importance.

The other two disease-producing bacteria occurring in different classes of raw milk are *Br. abortus* and the streptococci of mastitis in cows. Owing to the lack of reliable methods of examining *Br. abortus*, the extent of infection of milk from this organism was not so far realised. Minett and Pullinger have worked out methods for the examination of this organism and out of 65 samples examined by them, 48 or 73.8 per cent. gave positive results. Mastitis caused by streptococci is a common affection of the milking cow and the organisms commonly present do not endanger human health. The infection, however, reduces the quality of milk, as such a milk is deficient in fat and lactose and contains excess of chlorides and sometimes even blood proteins and lucocytes. The milk has an unpleasant salty taste and imparts a disagreeable flavour to the butter. Pasteurisation destroys all the organisms in the raw milk and safeguards the health of the consumer. To ensure complete freedom from all organisms, boiling at home is the safest method for the consumer. But apart from rendering the milk safe by heat treatment, it is imperative that a policy should be developed to eradicate the animal diseases communicable to man.

PASTEURISATION AND NUTRITIONAL VALUE.

This leads on to the question of the effect of heat treatment on the nutrition qualities of milk. It has been recently demonstrated that the ingestion of raw cows' milk—not pasteurised milk—by growing children prevents, to a large extent, the incidence of caries. The results of a series of very carefully planned experiments carried out by Dr. Elfrida Mattick and Captain John Golding at the National Institute for Research in Dairying, Reading, have definitely shown that sterilisation of cows' milk definitely lowers its value for the nutrition of young growing rats. Their development is impaired and there is a complete suppression of reproduction. The experiments conducted by Professor Drummond and co-workers, on the contrary, failed to demonstrate any such adverse effects of pasteurised milk. The work of Wilson and Cowell, on mice, which were also planned, in conjunction with Professor Drummond may be regarded as complementary to the work of Drummond on rats. These authors showed that the results obtained from raw and pasteurised milk regarding the numbers surviving, the average survival time, and the breeding records, are remarkably close. The differences, when they exist, are within the limits of experimental error. The experimenters, however, observed that while raw and pasteurised milks appear to be of approximately equal value for the growth and reproduction of mice subsequent to weaning, the raw milk is more advantageous than sterilised milk for the development of mice during the first four weeks of life. These considerations are all of the utmost importance, and although there is much to be said in favour of pasteurisation it may prove useful to supplement pasteurised milk diet with cod liver oil and orange juice for growing children.

CHEMICAL QUALITIES OF MILK.

For many generations past, the dairy cattle are being bred for volume and little attention is paid to the butter fat. The content of solids other than fat is rarely considered at all. There appears to be a negative correlation between volume and fat content and probably also between volume and solids—not fat. There is thus a growing need to turn our attention to the chemical constituents, and eliminate milk with poor nutritional and analytical quality. Remarkable results have been obtained in Denmark, where systematic breeding from animals of known quality has led to an increase both in the average yield of butter fat per lactation by 27 per cent. and the butter fat in the milk by 0·28 per cent. during 16 years. These results should encourage all producers in other countries, to follow similar methods, and the results will prove of lasting benefit both to the dairy industry and to the consumer.

BREAD.

"The manufacture of bread is as old as the hills, and was begun long before the word 'Science' had any meaning in commerce." While dealing with this established article of diet, one is faced, to-day, with the question of quality. Bread-making is now a factory operation, and as Vargus Eyre has put it—calling for mass production and the consequent moulding of processes to suit time-tables of production and this has brought in all kinds of small adjustments in order to secure the maximum output, the biggest loaves, and the lowest cost of production. If bread is to retain the qualities necessary for a staple food, it is necessary to examine the whole question anew, and find out in what processes of manufacture, bread loses its quality, and by what treatment the dietetic value of bread can be improved.

BLEACHING AGENTS AND IMPROVERS.

The endosperm of wheat contains a small amount of carotene which imparts a creamy colour to the flour. The miller, partly with the idea of effectively using those wheats, the endosperm of which is more yellow than others, and partly to make the flour more attractive, bleaches the flour. In this process the carotene is oxidised and bleached flour contains presumably, less vitamin A than the unbleached. Some bleaching agents like chlorine and nitrogen trichloride, not only bleach the flour, but also enhance its baking qualities. In modern baking practice certain improvers are added in minute quantities such as Ammonium persulphate and Potassium bromate, and the baker is thus enabled to use medium or even weak flours which possess only a low water absorption capacity, give a dough lacking in the desired characteristics of stability, elasticity and produce a small loaf. The questions connected with bleaching and improvers have been discussed by Kent-Jones who holds that the addition of these chemicals in the quantities used has no injurious effect on the consumer. The majority of those substances do not appear to affect even the flavour.

QUALITY OF WHEAT.

The results of general interest obtained by the Danish Home-grown Wheat Committee, 1929-33,

have been dealt with in an interesting paper by Holgen Jorgensen, who conducted the chemical and technical work of the Committee. The investigation on the agricultural aspects of the question reveals that the preceding crop (leguminous or non-leguminous) and the time of applying the nitrogenous fertilisers influences the nitrogen content of the wheat and by an appropriate adjustment of the cultural practices, the farmer can obtain a wheat of the desired nitrogen content. The changes in the total nitrogen content can be traced to the change in non-salt soluble protein or gluten. The addition of bromate increases the baking strength of flours, and generally speaking, a positive correlation exists between the nitrogen content of wheat and the ability of the flour to acquire an increased baking strength through the addition of bromate. From a baker's point of view, the most important protein is the gluten, which itself consists of two parts, the gliadin and the glutenin. These two proteins together give the gluten its characteristic properties of plasticity and elasticity and when it is mentioned that in water gliadin forms a sticky mass which can be stretched into threads, while glutenin forms a flaky mass without much coherence, it is at once realised that the baking property of flours is profoundly influenced by the proportions in which these two components of gluten occur.

The development of elastic properties and of distensibility in dough during fermentation under the continued pressure of carbon dioxide produced, are the two quality factors of flours. When the dough is prepared, certain chemical changes are brought about due to the enzymes present in the flour and the yeast. The effect of these changes on the consistency varies with flours of varying baking strengths. The dough may become soft, or with flours of good baking strengths, the consistency may even be increased.

THE DIETETIC VALUE OF BREAD.

From what has been said above, the baker is mainly concerned with the strength of the flour, and is not concerned with its dietetic value. The modern milling and bleaching processes give a flour devoid of the germ of the wheat constituting about 2 per cent. of the grain, and lacking in a large proportion of the mineral salts and vitamins originally present in the grain. The baking flour consists almost entirely of starch and gluten and is thus of only inferior nutritive value to the whole-meal. But it would appear extremely unlikely that there will ever be a wide-spread return to the whole-meal bread. For one thing, the whole-meal flour does not keep well and consequently there will be a difficulty in maintaining a continuous supply of sweet and sound flour. Further, the whole-meal bread is more difficultly digested than white bread and is not altogether well-suited to young people and to those that lead sedentary lives. The only alternative is to improve the quality of white bread.

The two sources of vitamins in bread are the germ of the wheat and the yeast used for the bread making. The former is got rid off in the preparation of the white flour, and the yeast added during the process of bread manufacture is inadequate to supply the vitamins in the necessary quantity. It has been shown by Drummond that the vitamin deficiency of the white bread is not made up by the other foods taken and this raises a very serious dietetic issue. How is it possible to raise the vitamin B content of bread? Yeast is perhaps the best source of vitamin B available and obviously by increasing the yeast content of the bread, the vitamin B content too is increased. Although in smaller bakeries, it would be easy to employ low temperatures, slower yeasts, more salt and vary other conditions so that it would be possible to incorporate more yeast in the bread, such alterations would not be practicable in urban areas where mass production necessitates short doughing processes, high temperatures and faster yeasts. It has been estimated that to make bread a sufficiently useful source of vitamin B in the diet, it would be necessary to raise the yeast content 5 or 6 times. The employment of such large quantities of fresh active yeast introduces several difficulties, but fortunately powdered baker's yeast which has little or no fermentative capacity on the dough, but possesses the full vitamin potency of the yeast, can be incorporated so as to give a bread satisfying normal conditions of growth and health maintenance. Dr. Varges Eyre, in his paper dealing with the value of yeast in bread, maintains that a "health bread" made from a "mixture of flour, dried yeast and fresh yeast would prove a popular and extremely beneficial food: it has the additional advantage of possessing flavour and does not become stale and dry so quickly."

MILK WITH BREAD.

With the main object of supplementing and balancing the nutritional value of bread, it is possible to incorporate dried milk, dried whey, and dried skim milk during its manufacture. If the addition is properly made to bring up the level to 4–6 per cent. of the original weight of flour, the resulting loaf improves both in flavour and keeping quality. This does not entail any additional cost but definitely improves the nutritional value of the finished article. The experimental work has already yielded satisfactory results, and as there is a growing appreciation and demand for bread of proved dietetic value, the time is ripe for the commercial exploitation by enterprising firms.

B. N. SASTRI.

Science News.

Referring to the letter about "An Interesting Case of the Insertion of the Leaves and Head in *Helianthus annus*, Linn" by Mr. S. A. Parandekar of Kolhapur, published in the *Current Science*, **2**, January 1934, p. 243, Mr. T. C. N. Singh, Assistant Economic Botanist in charge, Sabour, writes to draw the attention of the author to the abstract of a paper published in the *Proceedings of the 18th Indian Science Congress*, Nagpur, 1931, on pp. 270-271 where he has already recorded in brief the abnormalities described by Mr. Parandekar in the present communication.

* * *

Aligarh Muslim University.—At a joint meeting of the Muslim University Chemical and Physical Societies, convened for the purpose on the 21st February 1934, a paper by Professors R. F. Hunter and R. Samuel was read on "A Theory of Valency based on Wave Mechanics and Band Spectra" by Professor Hunter, the Chair being taken by the Pro-Vice-Chancellor, Mr. R. B. Ramsbotham, M.B.E., M.A., I.E.S.

It was shown that assumptions such as those of the co-ordinate linkage and the singlet link are physically inadmissible, and that Lowry's theory of the semipolar double bond although physically much sounder than Sidgwick's theory of co-ordination is impossible for energetic reasons. It was also pointed out that Sidgwick and Bayliss' later contention in connection with the expansion of valency group of hydrogen that a second quantum group is permissible (*J. Chem. Soc.*, 1930, 2027) has no meaning since wave mechanical calculations prove that it is impossible for electrons to enter the 2*s* group while the 1*s* group already possesses its maximum number of electrons; the curve of the potential energy of the third electron having no minimum and exhibiting only *repulsion* from the system.

* * *

Mr. B. S. Nigam, Agriculture College, Cawnpore, writing on "The Dispersal of *Tagetes erecta*" says:—Marigold (*Tagetes erecta*), a very commonly cultivated plant of the flower gardens, has been the subject of continued observation. Its inflorescence is a capitulum, borne singly on an elongated peduncle and the fruit is a Cypsela, with or without pappus, which has been known to disperse (Lowson and Sahni, B., *Text Book of Botany*) by its Parachute mechanism. In pappusless achenial fruits of compositæ the dispersal takes place by a Censor mechanism (Lowson and Sahni, B., *op. cit.*, p. 285.). Animal agency of dispersal has been observed in the case of *Tagetes erecta*; the agent being the common favourite bird the parrot, usually identified as an important garden thief. Parrots come in flower gardens and flock on trees, whence they fly down to the marigold beds, when the flowers are mature. They cut clean the peduncle with their sharp beaks and fly back to the perch with the capitulum. There they shed down the flowers on the ground below. The thalamus of the capitulum is swallowed in by them. After finishing with the first capitulum they make another pluck and this they continue with full zeal. Birds (Lowson and Sahni, B., *op. cit.*, p. 287) have been known to disperse by swallowing in the soft part of the inflorescence and dropping on the ground the hard part. In *Tagetes* the thalamus is swallowed in and the flowers are shed on the ground.

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The Cost of German Medical and Scientific Periodicals.—We understand from a report appearing in *Science*, **79**, 6, 1934, that as a result of a recent Conference held at Miinder and subsequent negotiations, mainly through the efforts of Charles H. Brown, Chairman of the Amercian Library Association and Mrs. Eileen R. Cunningham, Chairman of the Medical Library Association, Dr. Springer, one of the most influential German publishers, has announced a reduction of 30% on his most expensive Journals. It is likely that in the near future other German publishers will announce reductions in scientific publications so that libraries all over the world which are now faced with financial difficulty will be able to continue their subscription to German scientific periodicals.

* * *

The Chemist and Public Health.—Although the medical profession is considered to be of outstanding importance from the point of view of public health and life, E. Gabriel Jones in an interesting article (*J.S.C.I.*, **52**, 1024, 1933) set himself to show that the profession of chemistry, so often confused by "the man in the street" with the compounding of drugs, does play an important part in the preservation of health and life.

Medicine itself owes a great deal to the chemist. Pasteur, the founder of preventive diseases, was a chemist. Erlich's discovery of salvarsan and its application in the treatment of syphilis is one of the many instances of the importance of chemical research to medicine. The works of Carr, Drummond, Heilbrown, Rosenheim in the field of vitamins are surely important contributions of chemists towards prevention and cure of diseases. A branch of chemical profession which is closely connected with public health is that of the public analyst, who can justify his existence by suppression of fraud and adulteration and ensuring food supply free from harmful materials. The extensive consumption of tinned foods gives much work to the public analyst, for with foods of an acid character, tin as well as lead from the soldering may be dissolved in amounts which would prove injurious if ingested regularly. It is also known that many beverages which contain organic acids are solvents of lead and only last year outbreak of plumbism was reported from the neighbourhood of Exeter, due to cider which was drawn from casks through lead pipes. It is only recently that attention has been called to the risk of poisoning of antimony owing to the use of cheap enamelled vessels for acid drinks—the acids like citric and tartaric acid dissolving out antimony from the glaze containing antimony oxide. Three cases of antimony poisoning have been reported during the last five years.

In a large seaport, there is a necessity of chemical supervision of imported foodstuffs which, owing to faulty storage, may have become mouldy or have suffered decomposition.

A very important contribution of the chemist to public health is in connection with water supplies. The examination of water for pathological bacteria is the task of the bacteriologist.

Chemical analysis can show whether water is liable to be infected. The chemist can also find out whether a given water exerts a solvent action on metals with which it may come into contact. In Aberdeen the water supply of more than one hundred houses contained lead from lead joints of pipes, beyond safety limit; 51 out of 102 cases examined showed symptoms of lead poisoning and 2 deaths were attributed to the same cause. Cases are also recorded of illness like gastro-enterites due to zinc poisoning through the use of water stored in galvanized tanks. The problem of sewage disposal though largely a matter for the engineer, also concerns the chemist as failure to dispose off the sewage in a satisfactory manner would entail a menace to the health of the community.

The public analyst is often called upon to elucidate the cause of illness when milk, tea and such harmless commodities are suspected to be the cause of pains or undesirable symptoms. He is often required to undertake the analysis of air and rain water for atmospheric impurities, the treatment and purification of swimming baths which may be the source of disease transmission and similar other investigations necessary for maintenance of public health. These and many other contributions of the chemist in this field will prove beyond doubt that his share in safeguarding the health and life of the public is not a negligible one. There is a vast field for collaboration between chemistry and medicine and given the opportunity, the chemist will be ready to do his share.

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We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 133, Nos. 3350 to 3353.
"The Chemical Age," Vol. 29, No. 759 and Vol. 30, Nos. 760 to 762.
"The Journal of Chemical Physics," Vol. 2, No. 1.
"Berichte Der Deutschen Chemischen Gesellschaft," 67 Jahrg, No. 1.
"Experiment Station Record," Vol. 69, No. 6 and Index to Vol. 68.
"American Journal of Botany," Vol. 21, No. 1.
"The Review of Scientific Instruments," Vol. 5, No. 1.
"Scientific Indian," Vol. 11, No. 61.
"Indian Forester," Vol. 60, No. 2.
"Medico-Surgical Suggestions," Vol. 3, No. 1.
"Forschungen Und Fortschritte," 10 Jahrgang, No. 4.
"Journal of Agriculture and Livestock in India," Vol. 4, Part I.
"The Indian Journal of Agricultural Science," Vol. 3, Part 6.
"The Indian Journal of Medical Research," Vol. 21, No. 3.
"Indian Forest Records," Vol. 18, Part 11, and Vol. 19, Parts 4, 5, 6 and 7.
"The Indian Trade Journal," Vol. CXII, Nos. 1441 to 1444.
"Communications from the Kamerling Onnes Laboratory of the University of Leiden, Nos. 222 and 223, Suppt. No. 73 to Nos. 217-228, Suppt. No. 74 to Nos. 217-228, Suppt. No. 75 to Nos. 217-228.
"Actualites Scientifiques et Industrielles"
No. 67, Organisation et Principles de L'enseignement en U.R.S.S.
No. 76, L'Ancienne et La Nonvelle Logique.
No. 72, Les Espaces Metriques Fonde's Sun La Notion D'aire.

Reviews.

VECTORS FOR ELECTRICAL ENGINEERS. By E. Mallett. (Chapman & Hall, London, 1933.) Price 13*s*. 6*d*.

Although vector algebra is almost exclusively used in a-c. engineering design offices and numerous papers in technical journals contain its applications, one sees very little of it during a University course of Electrical Engineering. Most teachers and text-books of a-c. engineering lay great stress on vector diagrams and do not go beyond the fundamentals of vector algebra, probably through fear of a student getting absorbed in a mass of symbols and losing sight of the physical principles of apparatus and machinery that he is dealing with. In this book Dr. Mallett has shown how two powerful tools in the hands of an Electrical Engineer—the vector diagram and vector algebra—can work in harmony.

The book is quite self-contained. It starts with the fundamentals of vector algebra and vector loci which are first applied to simple circuits and then to well-known apparatus, machinery and complex circuits. Throughout the book vector and circuit diagrams are associated with vector algebra. Very little literature is available in English on the applications of the method of inversion to electrical engineering problems and its frequent use by the author is an important feature of this book.

Phase advancers and polyphase commutator motors are now standard machines and their inclusion would have added to the value of this book, specially as these complex machines lend themselves to easy treatment by vector algebra. It is hoped that the author will include them in the second edition and also give more applications of the interesting method of proof used on page 145 which, although well known to mathematicians, has not been used by Electrical Engineers to the extent it should be.

The book as a whole fulfils a real need of Power Engineers and would be valuable not

only to students and teachers but also to engineers already in practice.

J. J. R.

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PHYSICAL CHEMISTRY FOR STUDENTS OF BIOLOGY AND MEDICINE. By David Ingersoll Hitchcock. (Bailliere Tindall & Cox, London. Pp. x+182.) Price 15*s*.

Students of biology and medicine will welcome Prof. Hitchcock's "Physical Chemistry" as it fulfils a long-felt need for a work which provides a reading knowledge of the science of physical chemistry. Biology has recently emerged from its purely descriptive and speculative character and by adopting the methods of the exact sciences, has made vast strides. It is now recognised that the fundamental aspects of physiological phenomena can be explained in terms of physico-chemical principles.

The book is the outcome of the author's experience in training students of medicine at the York University. The matter is presented clearly and concisely in an eminently understandable language. The primary needs of the student are borne in mind; references to more comprehensive text-books are cited at the end of each chapter for the use of the ambitious student intent on gaining an extensive knowledge of the subject. Problems of a semiquantitative nature are included to illustrate theoretical principles. A useful bibliography of nearly a hundred citations is also added. These features make the book extremely useful and can be confidently recommended to medical students of Indian Universities.

The book contains 12 chapters dealing with subjects which find extensive application in biological work. The fundamental properties of crystalloidal and colloidal solutions, the laws governing reaction velocities, oxidation and reduction potentials, and energy transformations have all been included in the work. One would have wished for a more elaborate treatment of the laws of thermodynamics, and the inclusion of a chapter on photochemical phenomena.

The matter is printed on good paper and the get-up is excellent.

B. N. S.

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CHAPTERS IN MODERN INORGANIC AND THEORETICAL CHEMISTRY.—By Ernest S. Hedges. (Edward Arnold & Co., London, 1932. Pp. 279.) Price 12*s*. 6*d*.

Dr. Ernest Hedges is to be congratulated on his success in bringing out a text-book with a refreshingly broad outlook, presenting to the University students—for whom the book is primarily intended—the principal features of modern chemistry. To-day chemistry can hardly be successfully treated as organic, physical or inorganic—as separate entities; the science of chemistry must be treated as one united whole and the present book which emphasises this concept constitutes a very welcome departure from the usual text-books with which the student is familiar.

Our present knowledge concerning the precise properties accounting for or accompanying chemical reactivity is largely due to the intensive application of recent developments in Physics, both theoretical and experimental. The rapid progress achieved during recent years in the investigation of the nature of chemical processes and the obvious importance of the subject make it imperative that the University student should be initiated into the essentials of theoretical chemistry. Dr. Hedges has successfully dealt with the theoretical aspects in an understandable way for the benefit of the student.

The electronic theory has considerably helped to clarify our views on valency and chemical combination. The whole range of organic reactions can be explained on the basis of this theory, although a few difficulties have cropped up in its application in entirety. The chapters on complex ions, co-ordinated compounds, radioactivity, structure of atoms, isotopes, and atomic weight, are introductory to Chapter X on valency and chemical combination.

The purely descriptive portions are confined to the chemistry of less common elements and rare earths. The chapters on catalytic reaction, and corrosion and protection of metals include some important aspects of Applied Chemistry.

The book can be recommended as a text-book for students of Indian Universities.

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RECENT ADVANCES IN THE STUDY OF PLANT VIRUS. By Kenneth M. Smith. (J. and A. Churchill, London. Pp. xii + 423.) Price 15*s*.

Research on plant virus is in progress in all parts of the world. It is indeed difficult for the investigator to collect the available references relating to this problem, as they appear in diverse publications. Dr. Kenneth Smith is to be congratulated for his book, appearing as it does at an opportune moment, thus satisfying a long-felt want. The book

makes excellent reading, containing a coherent and succinct account of the investigations in the different aspects. The value of the book is enhanced by the analysis, side by side, of the researches in animal virus diseases.

Beginning with the introductory chapter, the author considers symptomatic effects which are so varying to serve as a diagnostic index. A good account of pathological histology also is presented. The occurrence of X-bodies has been noted only in a few cases. Unless these bodies—whatever may be the nature and composition of these—are traced in the tender and growing leaves resulting from infection, their utility and significance are of doubtful value. They are evidently formed as a reaction due to the virus.

An excellent treatment of the physical properties of the virus, is provided in the next two chapters, including a description of the methods of preparing graded collodion membranes and other methods employed elsewhere. Thus the book should be useful to botanists, bacteriologists and others.

Insects in relation to virus transmission form the subject-matter of three chapters wherein the author is at his best. Strangely enough, only three of the twenty-three orders of insects are incriminated in this transmission, chiefly Aphids, Jassids, etc. The question of specific biological relationship between the virus in the plant and its development in the insect body is of limited application. Recent evidences point to a casual mechanical transfer of infection. The mechanism of this transfer is rather difficult to explain, except to assume that the juice must be transported intact, without undergoing changes. Further, one insect is known to be carrier of several virus diseases, and one and the same disease, in a number of cases, is transmitted by different insects.

In the next four chapters, the author reviews the method of transmission other than through insects. The physiology of the diseased plants is considered on the lines of Henderson Smith's paper, while the metabolic changes in them must receive greater attention in a later edition. The general aspects of virus diseases of plants such as carriers, immunity, recovery, virus adaptations, the composite nature of viruses and their separation are presented in an excellent manner.

The last three chapters are meant to be a descriptive list of the various virus diseases affecting plants, which can by no means be claimed to be thorough or exhaustive. The items of crop losses and methods of control should, in the opinion of the reviewer, find a place at least in the future editions to render the compilation complete.

The book teems with citations till the middle of 1933 and the vast number of references in English are sufficient testimony to the volume of work, but it is as well to include other available literature on the subject. It is regrettable to find an omission of some of the earliest work. A useful index is appended both for the authors and the subjects.

In fine, the book is worth the price for at least the collections of references and must be in the hands of every virologist. The volume under review is adequately illustrated also.

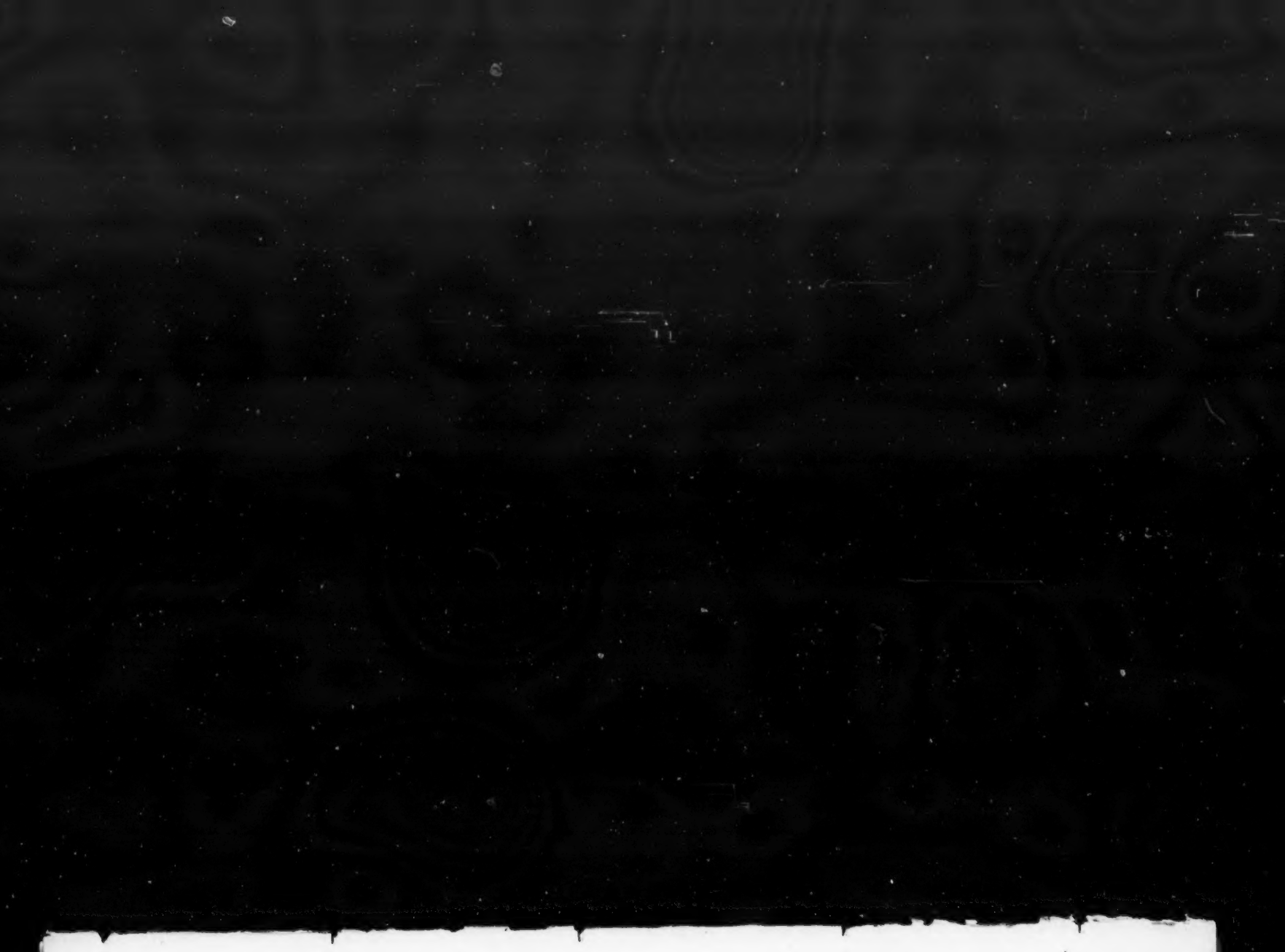
V. I.

Errata.

Page 287, column 1, line 1, *for* '*Castronodus strassenii*' *read* '*Gastronodus strassenii*'.

Page 288, column 2, lines 22 to 25, *for* "The cervical papillæ....anterior end (Fig. 1)" *read* "The excretory pore in the male measuring 30 mm. in length is at a distance of 1·16 mm. from the anterior end (Fig. 1)."

Page 288, column 2, Fig 1, *for* "Anterior end....papilla" *read* "Anterior end of male showing the excretory pore."

Page 290, column 1, line 10, *for* "M. B. Mirza" *read* "M. B. Mirza and Satya Narain Singh."

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